INSTALLATION RESTORATION PROGRAM

PRELIMINARY ASSESSMENT/ SITE INSPECTION REPORT

VOLUME I

143rd COMBAT COMMUNICATIONS SQUADRON
SEATTLE AIR NATIONAL GUARD STATION
WASHINGTON AIR NATIONAL GUARD
SEATTLE, WASHINGTON

MARCH 1995

AIR NATIONAL GUARD READINESS CENTER
ANDREWS AFB, MARYLAND

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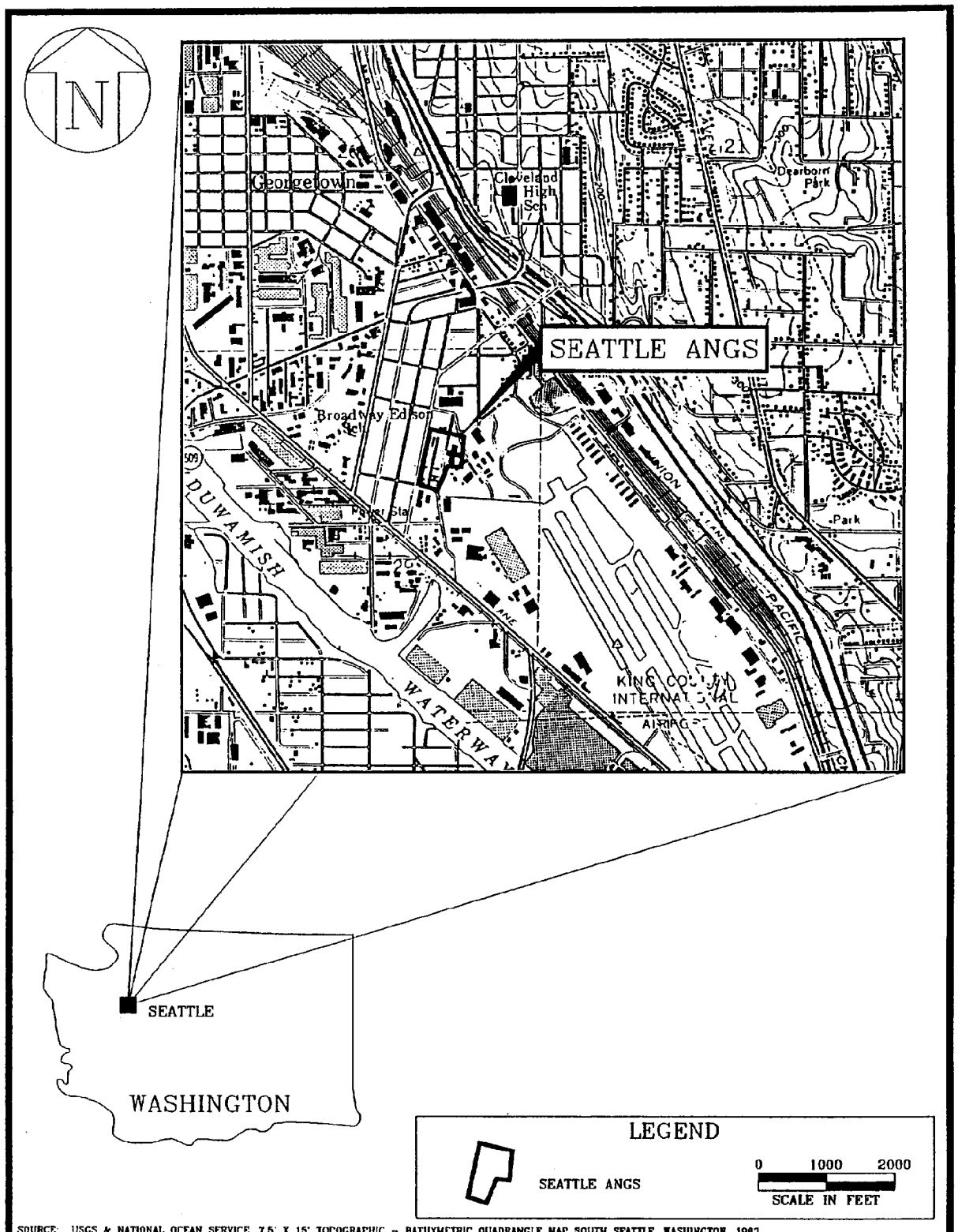

SOURCE: USGS & NATIONAL OCEAN SERVICE, 7.5' X 15' TOPOGRAPHIC – BATHYMETRIC QUADRANGLE MAP SOUTH SEATTLE, WASHINGTON, 1983.

INSIDE FRONT COVER
SEA-IFC

STATION LOCATION MAP

143rd CCSQ, Seattle ANGS

Seattle, Washington

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INSTALLATION RESTORATION PROGRAM

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VOLUME I

143rd COMBAT COMMUNICATIONS SQUADRON
SEATTLE AIR NATIONAL GUARD STATION
WASHINGTON AIR NATIONAL GUARD
SEATTLE, WASHINGTON

MARCH 1995

Prepared For

AIR NATIONAL GUARD READINESS CENTER
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LIST OF ACRONYMS

AGE	Aerospace Ground Equipment
ANGRC	Air National Guard Readiness Center
ANGRC/CEVR	Air National Guard Readiness Center/Installation Restoration Program Branch
ANGS	Air National Guard Station
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
ATHA	Ambient temperature headspace analysis
BLS	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CCSQ	Combat Communication Squadron
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DOE	Department of Ecology
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
EO	Executive Order
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
FTA	Fire-training area
GC	Gas Chromatograph
GPR	Ground-penetrating radar
HDPE	High-density polyethylene
HM/HW	Hazardous materials/hazardous wastes
HRS	Hazard Ranking System
HSA	Hollow-stem auger
IRP	Installation Restoration Program
MCL	Maximum Contaminant Level
MEK	Methyl ethyl ketone
mg/L	milligrams per liter
MHz	Megahertz
mL	milliliter
MOGAS	Motor vehicle gasoline
MSL	Mean Sea Level
MTCA	Model Toxics Control Act
MW	Monitor Well
ns	nanoseconds
PA	Preliminary Assessment
PA/SI	Preliminary Assessment/Site Inspection
PCBs	Polychlorinated Biphenyls
pCi/g	picoCuries per gram

LIST OF ACRONYMS (Concluded)

pCi/L	picoCuries per liter
PID	Photoionization Detector
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
ppmv	parts per million volume
PVC	Polyvinyl chloride
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act
SI	Site Inspection
SIR	Subsurface Interface Radar
SVOC	Semivolatile Organic Compound
TEG	Transglobal Environmental Geosciences, Northwest, Inc.
TPH	Total Petroleum Hydrocarbons
TVH	Total Volatile Hydrocarbons
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground storage tank
UTA	Unit Training Assembly
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound

Executive Summary

INSTALLATION RESTORATION PROGRAM
PRELIMINARY ASSESSMENT/SITE INSPECTION

EXECUTIVE SUMMARY

ES 1.0 INTRODUCTION

A Preliminary Assessment/Site Inspection (PA/SI) was conducted at the 143rd Combat Communications Squadron (CCSQ), Seattle Air National Guard Station (ANGS), Seattle, Washington. The Air National Guard Readiness Center/Installation Restoration Program Branch (ANGRC/CEVR) authorized Operational Technologies Corporation (OpTech) to prepare a PA/SI Work Plan and conduct the SI at the Seattle ANGS. A PA of the 143rd CCSQ, Seattle ANGS, was initiated by ANGRC personnel in December 1991. Information obtained through interviews, review of station records, and field observations resulted in the identification of one potentially contaminated disposal and/or spill area. This area was designated as the Burial Site Area of Concern (AOC). The SI was conducted as outlined in the PA/SI Work Plan submitted to ANGRC/CEVR in January 1994 and approved in April 1994. The field work commenced at the 143rd CCSQ on 5 July 1994 and was completed on 27 July 1994.

ES 2.0 AREA OF CONCERN

The Burial Site AOC is located in the northeast corner of Seattle ANGS. From the early 1950s to 1968, various waste items were burned and buried in the area northeast of the old gravel parking lot. Presently, the majority of the site is covered with asphalt and used for vehicle parking, with the exception of the northeast corner, which is covered with grass. This SI was performed to determine whether contamination may be detected at this location as a result of past burial and burning activities.

ES 3.0 SITE INSPECTION FINDINGS

Thirteen soil and groundwater samples from the Burial Site AOC were submitted for laboratory analysis of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), priority pollutant metals, pesticides/polychlorinated biphenyls (PCBs), total petroleum hydrocarbons (TPH), and gross alpha and gross beta radiation.

The SVOC di-n-butyl phthalate (a common laboratory contaminant) was detected in eight of nine soil samples, with a maximum detected concentration of 1,960 micrograms per kilogram

(μg/kg). This is well below the Washington Department of Ecology (DOE) Model Toxics Control Act (MTCA) Method B cleanup level of 8,000 mg/kg. Only one metal was detected in soil samples at concentrations exceeding Washington DOE cleanup levels. Beryllium was detected at a maximum concentration of 1.1 milligrams per kilogram (mg/kg), which exceeds the MTCA Method B level of 0.233 mg/kg. The average and maximum concentrations detected for beryllium are below or approximately equal to the range of naturally-occurring concentrations. TPH was detected in two soil samples from one boring, namely BS-003BH, at concentrations of 780 and 160 mg/kg. The higher TPH concentration exceeds the Washington DOE cleanup level for TPH of 200 mg/kg. Gross alpha and gross beta radiation were detected at concentrations ranging from 0 to 4 picoCuries per gram (pCi/g) and 0 to 4 pCi/g, respectively. There are no Federal or State action levels for gross alpha and gross beta radiation in soils. The background levels detected in soil at this AOC are 0 pCi/g for both gross alpha and gross beta radiation.

In two groundwater samples, four metals exceeded Washington DOE levels. Specifically, these are: arsenic at 0.028 mg/L exceeds MTCA Method A level of 0.005 mg/L, beryllium at 0.82 mg/L exceeds MTCA Method B level of 0.00002 mg/L, chromium at 0.097 mg/L exceeds MTCA Method A level of 0.05 mg/L, and lead at 0.026 mg/L exceeds MTCA Method A level of 0.005 mg/L. The average and maximum concentrations for these metals detected in groundwater samples are below their respective site-specific background levels except for beryllium. Gross alpha and gross beta radiation were also detected in groundwater samples. Gross alpha and gross beta were detected at concentrations ranging from 15 picoCuries per liter (pCi/L) to 59 pCi/L and 58 pCi/L to 77 pCi/L, respectively. The State action level for gross alpha radiation in groundwater is 15.0 pCi/L. The Federal Maximum Contaminant Level (MCL) for gross beta radiation in drinking water is 50 pCi/L. The background radiation levels detected in groundwater at this AOC are 36 pCi/L for gross alpha and 78 pCi/L for gross beta.

ES 4.0 CONCLUSIONS

TPH was detected in two soil samples from one boring (BS-003BH), with one of the detections being significantly above the MTCA Method A cleanup level of 200 mg/kg. Detected concentrations of the metals arsenic, beryllium, chromium, and lead variously exceeded MTCA limits, yet the average and maximum of the detected concentrations in respective media does not exceed site-specific background or naturally-occurring concentrations, except for beryllium in groundwater. Gross alpha radiation was detected above MTCA Method A cleanup level of 15.0 pCi/L in two groundwater samples, one of which was the background groundwater sample.

Gross beta radiation was detected above the Federal MCL of 50 pCi/L in three groundwater samples, one of which was the background groundwater sample.

ES 5.0 RECOMMENDATIONS

Based on the results of the PA/SI conducted, further investigation is recommended to determine the source and areal extent of TPH contamination detected in borehole BS-003BH, and the gross alpha and gross beta radiation detected in the groundwater samples collected at the Burial Site AOC.

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Section 1

SECTION 1.0 INTRODUCTION

1.1 BACKGROUND

This Report presents the results of the Preliminary Assessment/Site Inspection (PA/SI) activities conducted at the 143rd Combat Communications Squadron (CCSQ), Seattle Air National Guard Station (ANGS), Seattle, Washington (see Inside Front Cover Figure). The Air National Guard Readiness Center/Installation Restoration Branch (ANGRC/CEVR) authorized Operational Technologies Corporation (OpTech) to prepare a PA/SI Work Plan and conduct the Site Inspection (SI) at the Seattle ANGS. A Preliminary Assessment (PA) of the 143rd CCSQ, Seattle ANGS, was initiated by ANGRC personnel in December 1991. Information obtained through interviews, review of station records, and field observations resulted in the identification of one potentially contaminated disposal and/or spill area. This area was designated as the Burial Site Area of Concern (AOC). The SI was conducted as outlined in the PA/SI Work Plan submitted to ANGRC/CEVR in January 1994 and approved in April 1994. The PA/SI is conducted under the authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

The Defense Environmental Restoration Program (DERP) was established in 1984 to promote and coordinate efforts for the evaluation and cleanup of contamination at Department of Defense (DoD) installations. On 23 January 1987, Presidential Executive Order (EO) 12580 assigned specific responsibility to the Secretary of Defense for carrying out DERP within the overall framework of the SARA and CERCLA of 1980. The Installation Restoration Program (IRP) was established under DERP to identify, investigate, and clean up contamination at DoD installations. The IRP focused on cleanup of contamination associated with past DoD activities to ensure that threats to public health were eliminated and natural resources were restored for future use. Within the Air National Guard, ANGRC/CEVR manages the IRP and related activities.

1.2 PURPOSE

The overall objective of the PA/SI was to identify and evaluate potential areas of concern associated with past waste handling procedures, disposal and spill areas. This objective has been met through the PA and SI activities. The PA (1991) consisted of personnel interviews and a records search designed to identify and evaluate past disposal and/or spill areas that might pose a potential and/or actual hazard to public health, public welfare, or the environment. The SI

consisted of field activities designed to confirm or deny the presence of contamination at the AOC identified in the PA (1991). In addition, this PA/SI Report provides specific information required to complete the Hazard Ranking System (HRS) "Data Requirements for Federal Facility Docket Sites" (Appendix G).

The specific objectives of the PA/SI were to:

- Identify all operations at the station that have used hazardous materials or have generated hazardous waste.

- Obtain available geological, hydrological, meteorological, and environmental data and define hydrogeologic conditions that affect contaminant migration, containment, or cleanup.

- Provide data to assist in determining the presence, type, magnitudes, or absence of contamination at the AOC.

- Support site-specific decisions, such as no further action or identification of the AOC as requiring further investigation in the form of a Remedial Investigation/Feasibility Study (RI/FS).

1.3 SCOPE

The scope of work for the PA/SI was to identify potential areas of concern through PA activities and to confirm or deny the presence of contamination associated with past hazardous material and hazardous waste handling and disposal through SI activities. The scope was limited to areas under the primary control of Seattle ANGS. Also, the scope was limited in that the extent of contamination at the AOC and the extent of possible threats to human health and the environment were not determined during this PA/SI. Therefore, within these limits, the PA/SI included the following actions: the identification of AOCs at or under primary control of the ANGS and the evaluation of potential receptors; the definition of the nature of releases at the identified AOC; the confirmation of the absence or presence of soil and groundwater contamination; and description of the geologic conditions of the installation study area, including the subsurface soil types and the presence or absence of hydrogeologic confining layers; and the definition of hydrogeologic conditions, such as groundwater flow direction. The results of this PA/SI provide the technical basis needed to reach a decision point for the AOC.

1.4 METHODOLOGY

1.4.1 Preliminary Assessment Process

The purpose of the PA is to identify and evaluate the historical use, disposal, or release of hazardous materials and hazardous wastes (HM/HW) on an installation that may pose a potential or actual hazard to public health, public welfare, or the environment. A flow chart of the PA Methodology employed at Seattle ANGS is presented in Figure 1.1.

The PA (1991) began with a visit to Seattle ANGS to evaluate both past and present HM/HW handling procedures in order to determine whether any environmental contamination has occurred. The evaluation of past HM/HW handling practices was facilitated by interviews with four station personnel familiar with the various operating procedures at the station. These interviews defined the areas at the station where HM/HW was stored, spilled, disposed of, or otherwise released into the environment.

Historic records from station files were collected and reviewed to supplement the information obtained from the interviews. Using this information, a list of past waste spill/disposal areas on the station was identified for further evaluation. A general survey tour of the identified spill/disposal areas and the station was conducted to determine the presence of visible contamination and to help assess the potential for contaminant migration. Particular attention was given to locating nearby drainage ditches, surface water bodies, and residences.

Detailed geological, hydrological, meteorological, developmental (land use and zoning), and environmental data for the Seattle area were also obtained from appropriate Federal, State, and local agencies. Following a detailed analysis of all the information obtained, the AOC was identified, described in detail and recommended for SI activities included in the PA/SI Work Plan.

1.4.2 Site Inspection Process

The purpose of the SI is to perform field activities to confirm or deny the presence of contamination at the identified AOC. The SI was accomplished at Seattle ANGS by performing a geophysical survey, conducting a soil vapor survey, drilling soil borings and collecting subsurface soil samples, and drilling piezometers and collecting groundwater samples. These samples were field screened using a photoionization detector (PID) and a field gas chromatograph (GC), and were subsequently analyzed for laboratory parameters related to the

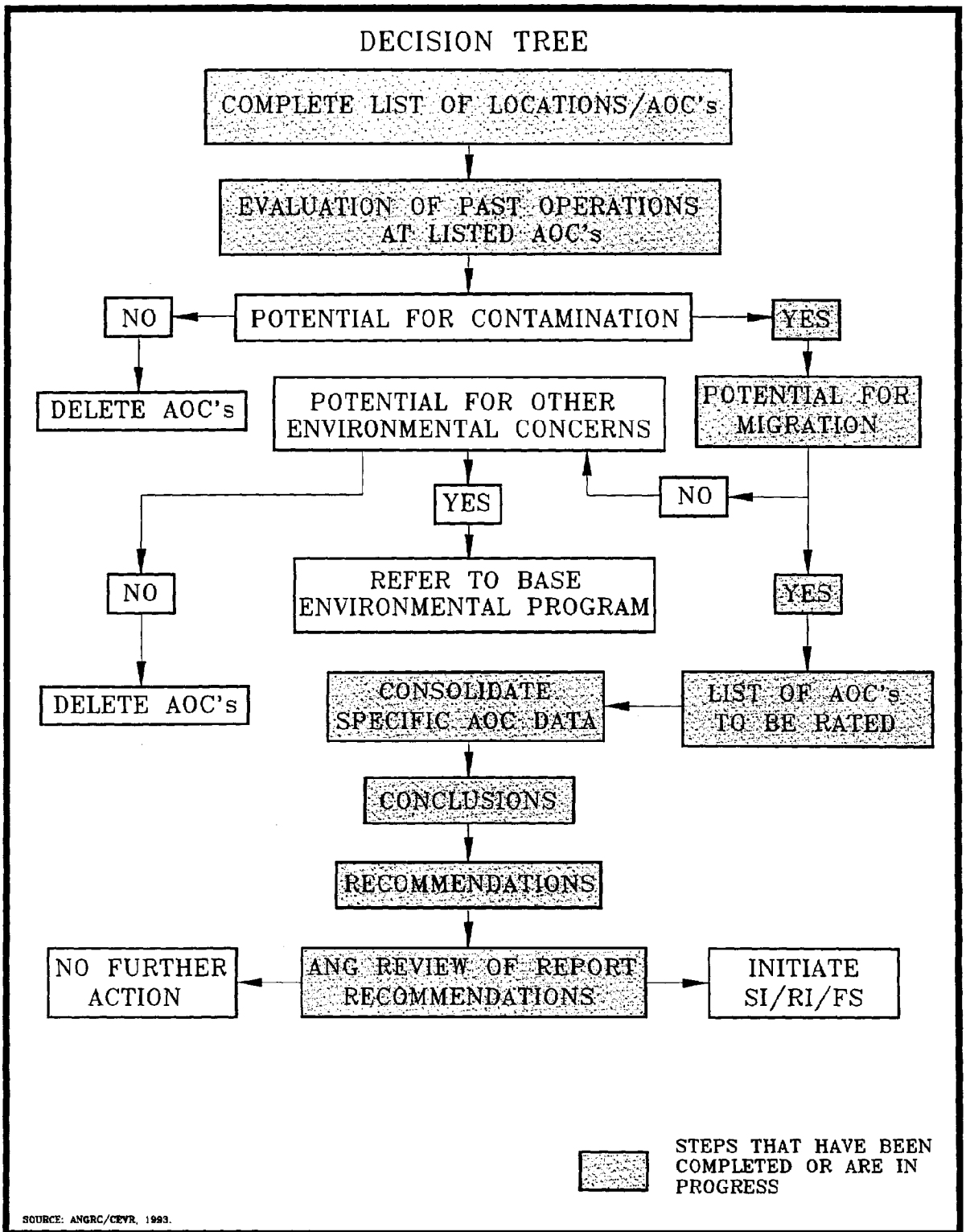

FIGURE 1.1

FORMS\PAMC-AD.

PRELIMINARY ASSESSMENT METHODOLOGY CHART
143rd CCSQ, Seattle ANGS
Seattle, Washington

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suspected contaminants identified in the PA (1991). The findings of both the initial PA station visit and the SI field activities are presented in this PA/SI Report.

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Section 2

SECTION 2.0 INSTALLATION DESCRIPTION

2.1 LOCATION

Seattle ANGS is located at 6736 Ellis Avenue South, Seattle, Washington. The station property is situated northeast of the intersection of Ellis Avenue South and Willow Street. The station encompasses approximately 7.5 acres of flat terrain and is located in the northwest portion of Boeing Field (King County International Airport) (see Figure 2.1).

As shown in Figure 2.2, Seattle ANGS consists of a Communications/Administration Building (Building 201), an Aerospace Ground Equipment (AGE)/Motor Vehicle Building (Building 202), a Paint Storage Building (Building 203), and Mobility Storage (Building 204).

Seattle ANGS has a normal working population of 24 people. The station serves as a site for Unit Training Assembly (UTA) which meets one weekend per month. During this weekend, the station population reaches approximately 158.

2.2 ORGANIZATION AND HISTORY

Seattle ANGS was built during World War II by the War Department and was used by the Army Air Force as the "Aircraft Factory School" during the war. In 1948, the property was given to King County as surplus property and was subsequently leased to the Washington Air National Guard.

On 21 April 1948, the 143rd Aircraft Control and Warning Squadron was established. From May 1951 to February 1953, the 143rd was activated for recruitment purposes. During this period of time, the unit had two C-47 aircraft. In 1960, the name of the unit was formally changed to the 143rd Communications Squadron Tributary Teams. In 1969 and 1988, the name of the unit was again changed, becoming the 143rd Mobile Communications Squadron and the 143rd CCSQ, respectively. The current mission of the 143rd CCSQ is to provide mobile communication support and telephone/teletype support for airports and airfields.

In 1948, the station consisted of 17 acres of land, including an aircraft parking ramp, leased from King County. At that time, the property contained 15 buildings (including a number of small shed structures), all of which were subsequently demolished. No site plans or photographs depicting these buildings or the general station layout are available. In 1951, a new property lease decreased the size of the station from 17 acres to its present size of 7.5 acres, and

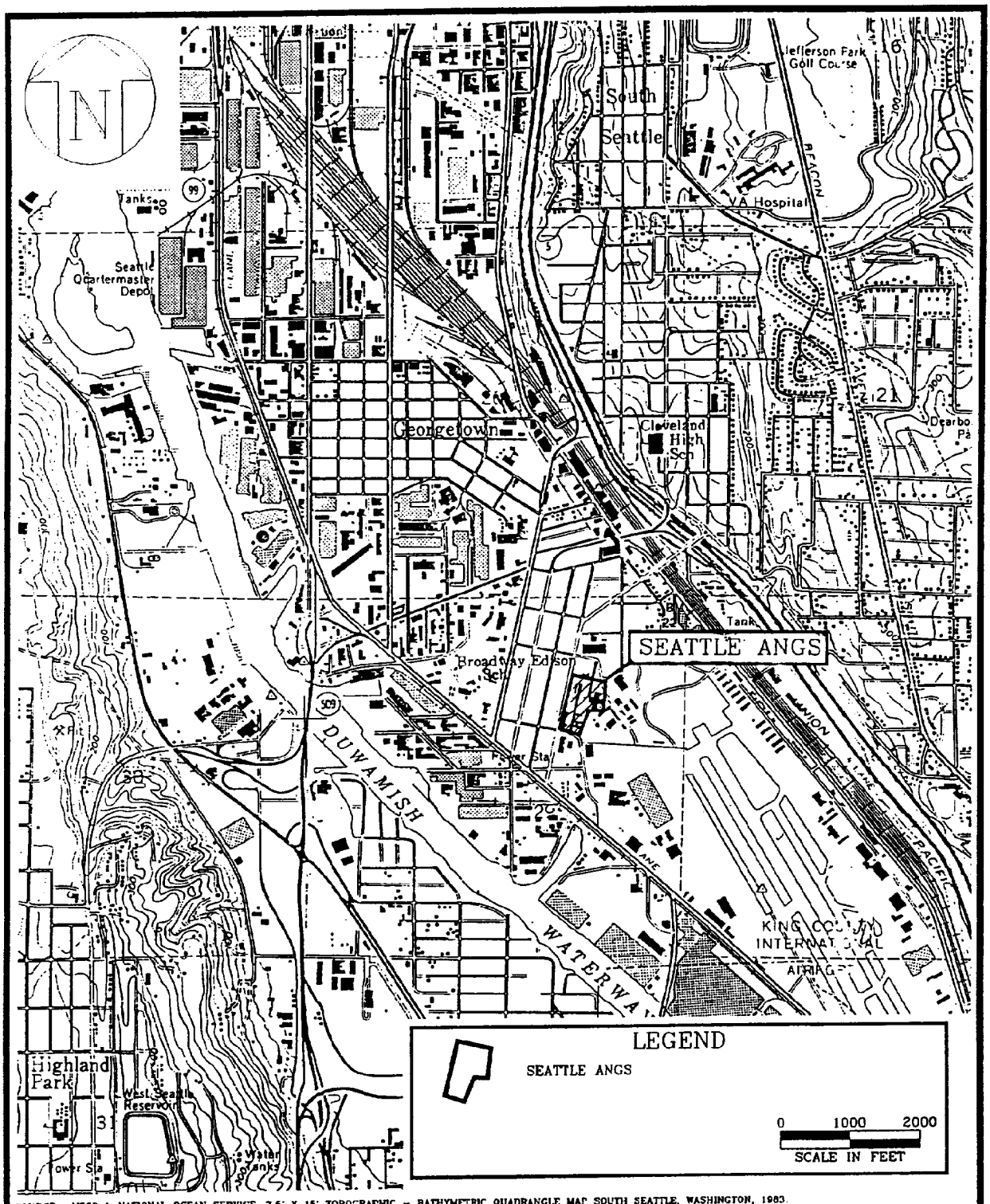

FIGURE 2.1

SEATTLE\SEA4-1LO

7.5' x 15' TOPOGRAPHIC MAP

143rd CCSQ, Seattle ANGS
Seattle, Washington

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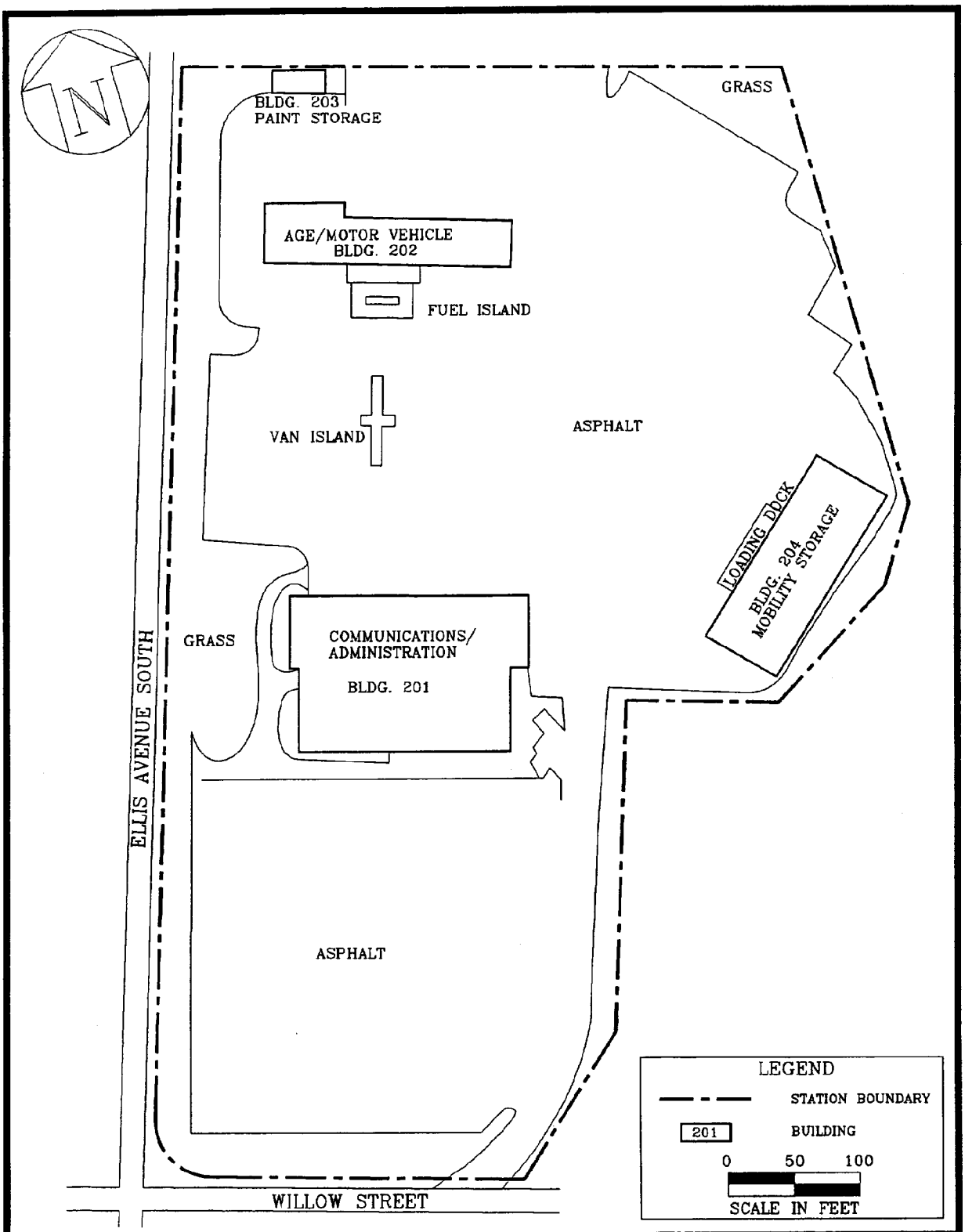

FIGURE 2.2

SEATTLE\SEA1-2SE

SEATTLE ANGS IN 1994
143rd CCSQ, Seattle ANGS
Seattle, Washington

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buildings were constructed for headquarter, mess hall, warehouse, and vehicle service requirements (Figure 2.3). In 1980, the National Guard Bureau approved and Congress funded $2.3 million for replacement of all buildings. The buildings were completed in 1984, with the exception of the Mobility Warehouse, which was completed in 1988. Seattle ANGS now consists of 7.5 acres and four buildings (34,698 total square feet). The Seattle ANGS property is leased from King County by the U. S. Air Force, who in turn licenses the property to the Washington State Military Department for Air National Guard use.

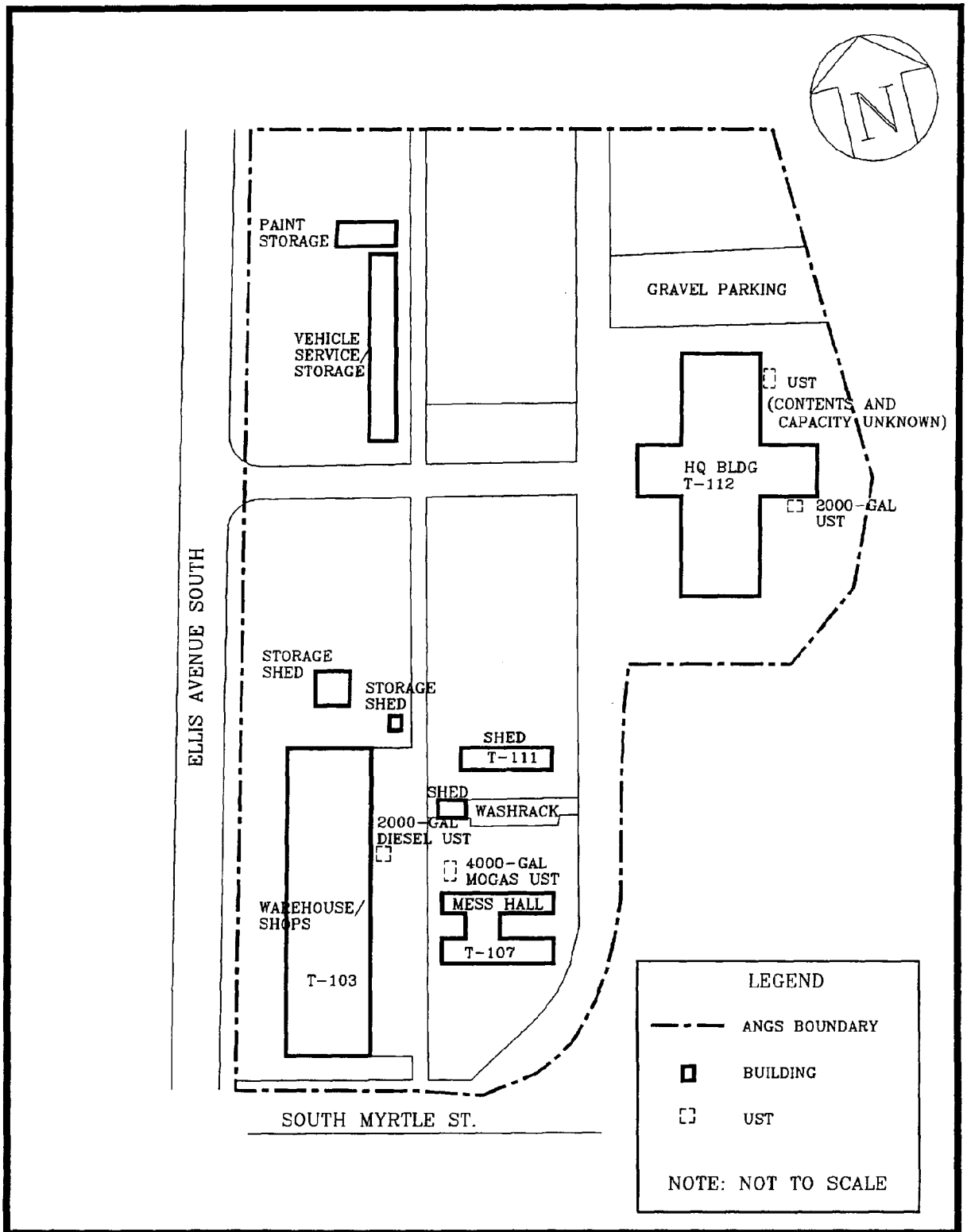

FIGURE 2.3

P\SEATTLE\SEA-1984

SEATTLE ANGS PRIOR TO 1984 RECONSTRUCTION
143rd CCSQ, Seattle ANGS
Seattle, Washington

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Section 3

SECTION 3.0 ENVIRONMENTAL SETTING

Seattle ANGS is located in King County in the Puget Sound Lowlands physiographic province (see Figure 3.1). The Puget Sound Lowlands is a north-south trending structural and topographic depression bordered on the west side by the Olympic Mountains and on the east by the Cascade Range. The Lowlands extend north from the Oregon-Washington State line to the Canadian border.

3.1 METEOROLOGY

The climate in the Seattle area is characterized by mild summers and cool winters, with long spring and fall seasons. In winter the daily temperatures range from 37° F to 47° F, while in summer the daily temperatures range from 55° F to 72° F. The average annual precipitation is 38.84 inches, including 7.4 inches of snow. The greatest percentage of rainfall occurs in the winter months from November to January. The average monthly precipitation ranges from 0.89 inches in July to 6.29 inches in December. The heaviest 24-hour rainfall of 3.74 inches was recorded on October 5-6, 1981. Rainfall intensity, based on a 2-year, 24-hour duration, is 2.0 inches. Free water surface evaporation in the Seattle area is approximately 25 inches per year, resulting in a net precipitation of 13.84 inches per year. The prevailing wind is from the southwest, and the highest average wind speed of 9.8 miles per hour is experienced during the month of March.

3.2 GEOLOGY

The Seattle ANGS is situated in the southern portion of the Puget Sound Lowlands, a broad, relatively level glacial drift plain that is dissected by a network of deep marine embayments. The site is located within the north-south trending Duwamish Valley on the Duwamish Waterway floodplain, formerly a marine embayment that has been filled with sediment since the end of the last glaciation, referred to locally as the Vashon Glaciation of Pleistocene Age (Luzier, 1969). The station is located on flat terrain within the flood plain of the Duwamish River, with a surface elevation of approximately 7 feet above mean sea level (MSL). The valley is bounded to the east and west by uplands. Figure 3.2 is a geologic map of the area, and Figure 3.3 shows a stratigraphic column for the Puget Sound Lowlands.

Sediments (collectively termed Vashon Drift), representing the last major advance and retreat of glacial ice into the Puget Sound area, commonly overlie the sequence of older glacial and

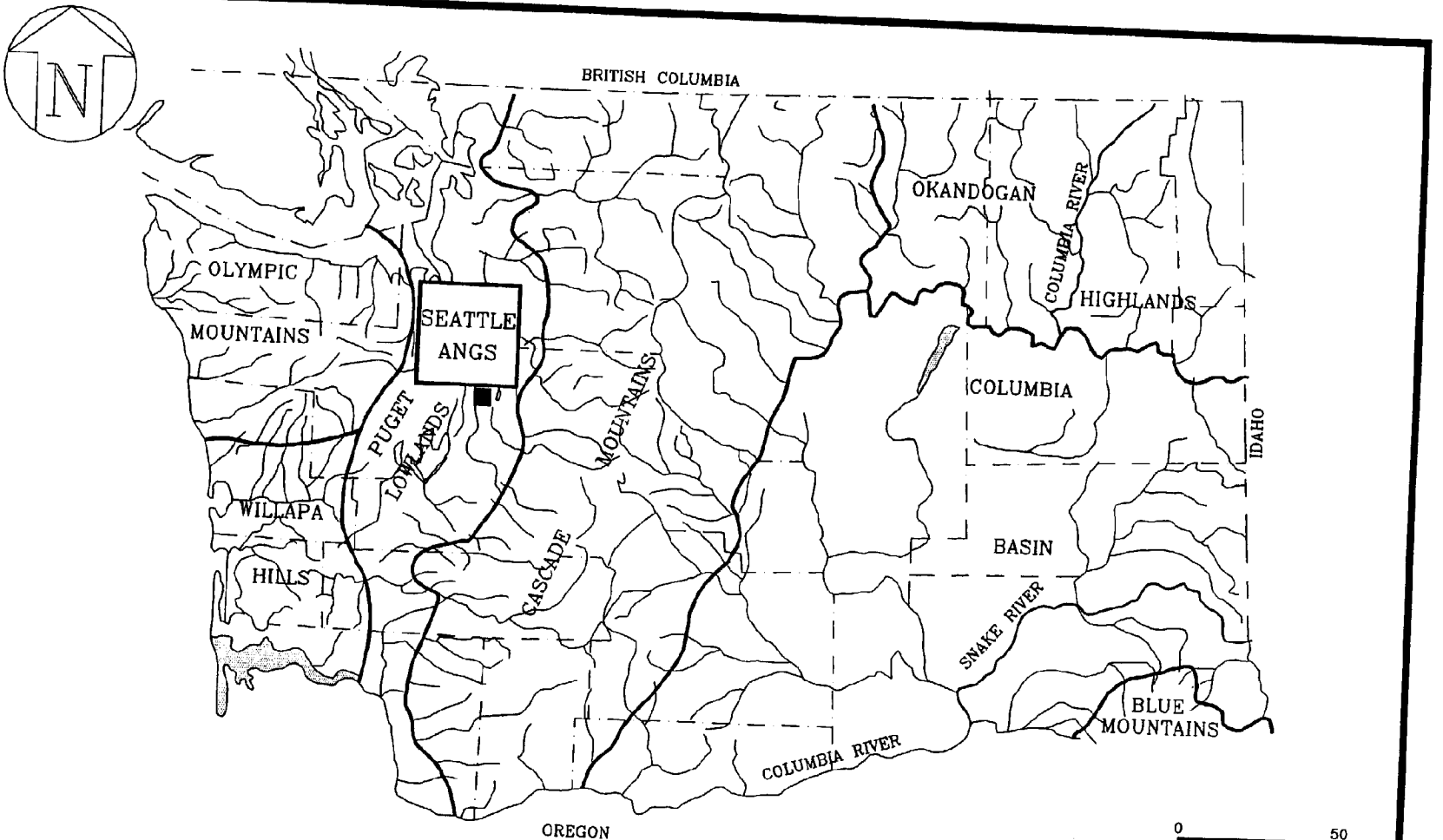

FIGURE 3.1

SEATTLE\SEA4-3PH

PHYSIOGRAPHIC DIVISIONS OF THE STATE OF WASHINGTON
143rd CCSQ, Seattle ANGS
Seattle, Washington

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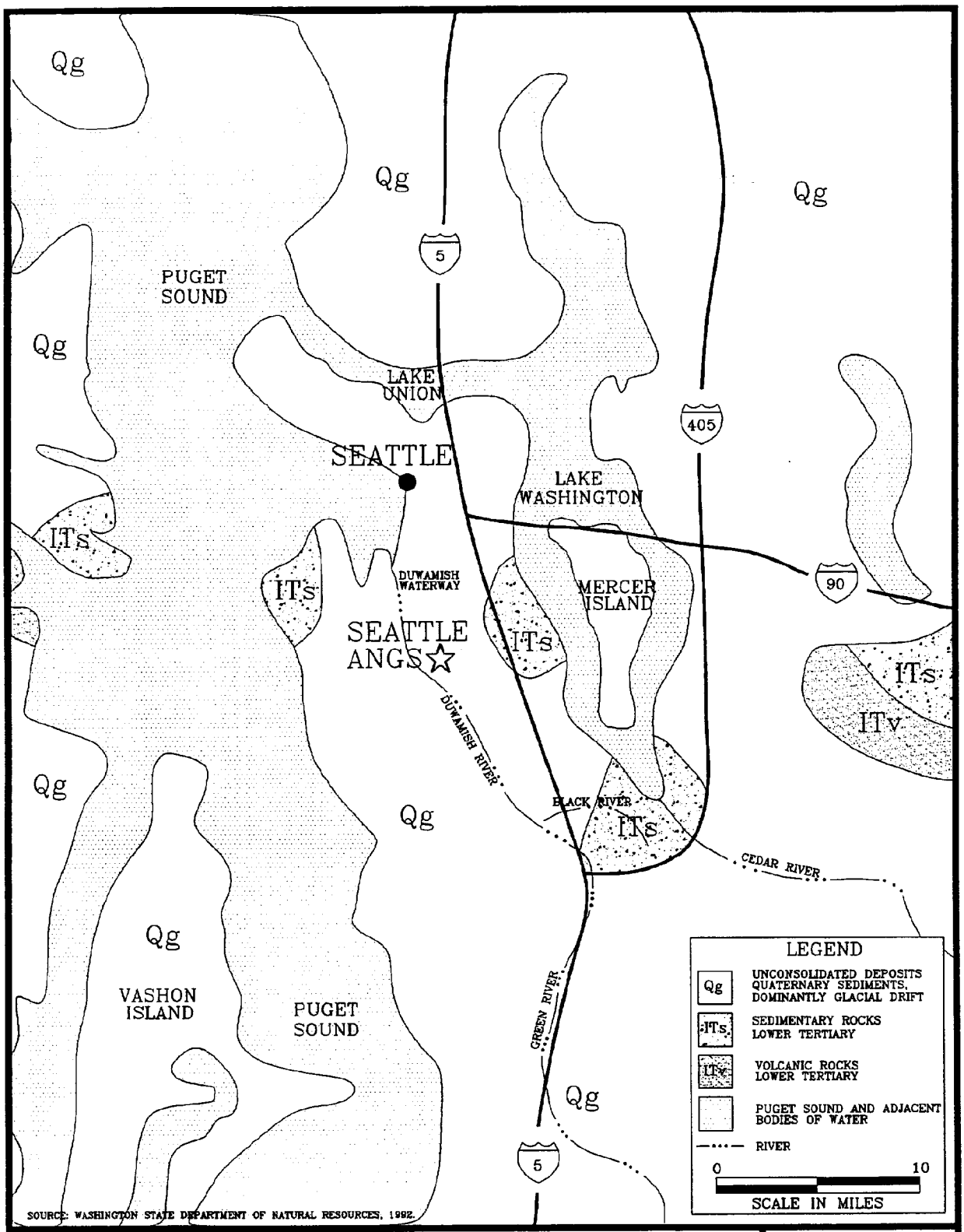

FIGURE 3.2

SEATTLE\SEA-SOIL

GEOLOGIC MAP OF THE VICINITY OF SEATTLE ANGS

143rd CCSQ, Seattle ANGS
Seattle, Washington

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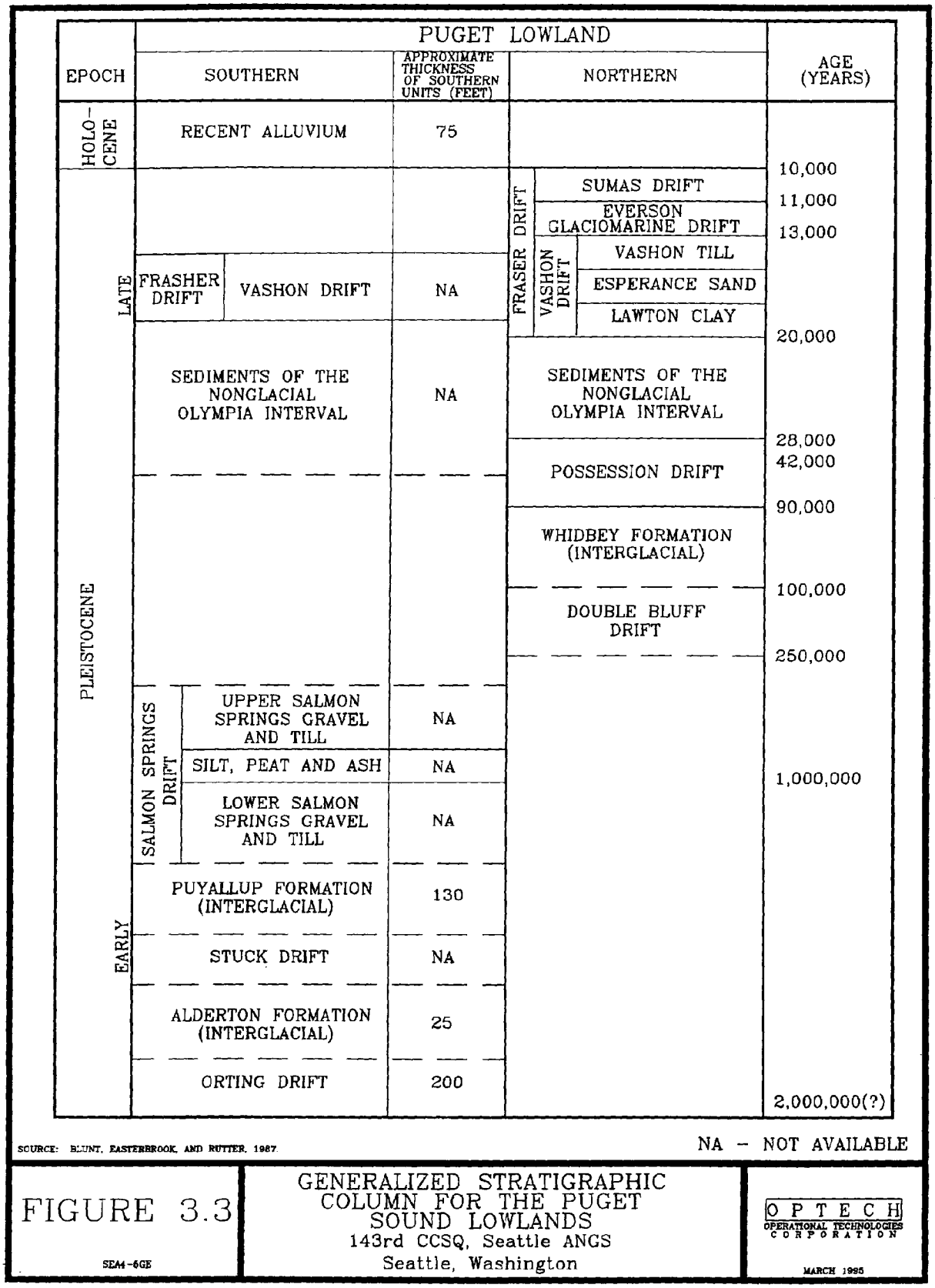

SOURCE: BLUNT, EASTERBROOK, AND RUTTER, 1987.

NA – NOT AVAILABLE

FIGURE 3.3

SEA4-6GE

GENERALIZED STRATIGRAPHIC COLUMN FOR THE PUGET SOUND LOWLANDS
143rd CCSQ, Seattle ANGS
Seattle, Washington

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nonglacial sediments throughout the site vicinity. In the North Boeing Field area, at least 75 feet of recent alluvium deposited by the Duwamish River is underlain by Vashon Drift deposits.

Alluvial deposits are composed primarily of sand and silty sand interbedded with silt. The alluvial deposits exhibit gradation common to braided rivers which have resulted in intermittent layering of sands with occasional layers of peat and organic materials being deposited in previous low-lying marsh areas. Additionally, much of the valley floor has been raised with more recent fill to accommodate development within the valley.

3.3 SOILS

The United States Department of Agriculture classified the soil underlying the Seattle ANGS as unclassified urban land. Urban land is soil that has been modified by disturbance of the natural layers with additions of fill material several feet thick to accommodate large industrial and housing installations. In the Duwamish River Valley, the fill ranges from about 3 to more than 12 feet thick, and from gravelly sandy loam to gravelly loam in texture. The erosion hazard is slight to moderate.

Five Dutch cone penetrometer samples (hereinafter referred to as probes) and two borings, drilled by Hart Crowser and Associates, Inc., during soil studies conducted in 1974 and 1982 at Seattle ANGS, show sandy silt to silty sand to be the most common soil within the uppermost 10 feet of unconsolidated sediments, below which sand, with occasional thin silty layers, is the predominant soil type to a depth of 50 feet below land surface (BLS). The Dutch cone penetrometer is an instrument used in geotechnical investigations to measure soil strength. The system is mounted on a truck and a probe is driven into the ground. A direct correlation is obtained between the point resistance of the cone and bearing capacity of the soil, and the relative density or consistency of the soil is then calculated.

3.4 SURFACE WATER HYDROLOGY

The Seattle ANG Station is located approximately a quarter mile from the main channel of the Duwamish Waterway, a major surface water drainage basin for western Washington (see Figures 3.2 and 3.4). Between 1917 and 1919, the meanders of the Duwamish River were filled in and the Duwamish Waterway was constructed. The western end of the meander near North Boeing Field was not filled and became the present day Slip No. 4. The Federal Emergency Management Agency (FEMA) reported the drainage basin of the Duwamish as 450 square miles. The Waterway is composed of the Duwamish and the Green Rivers. Approximately 5.5 miles

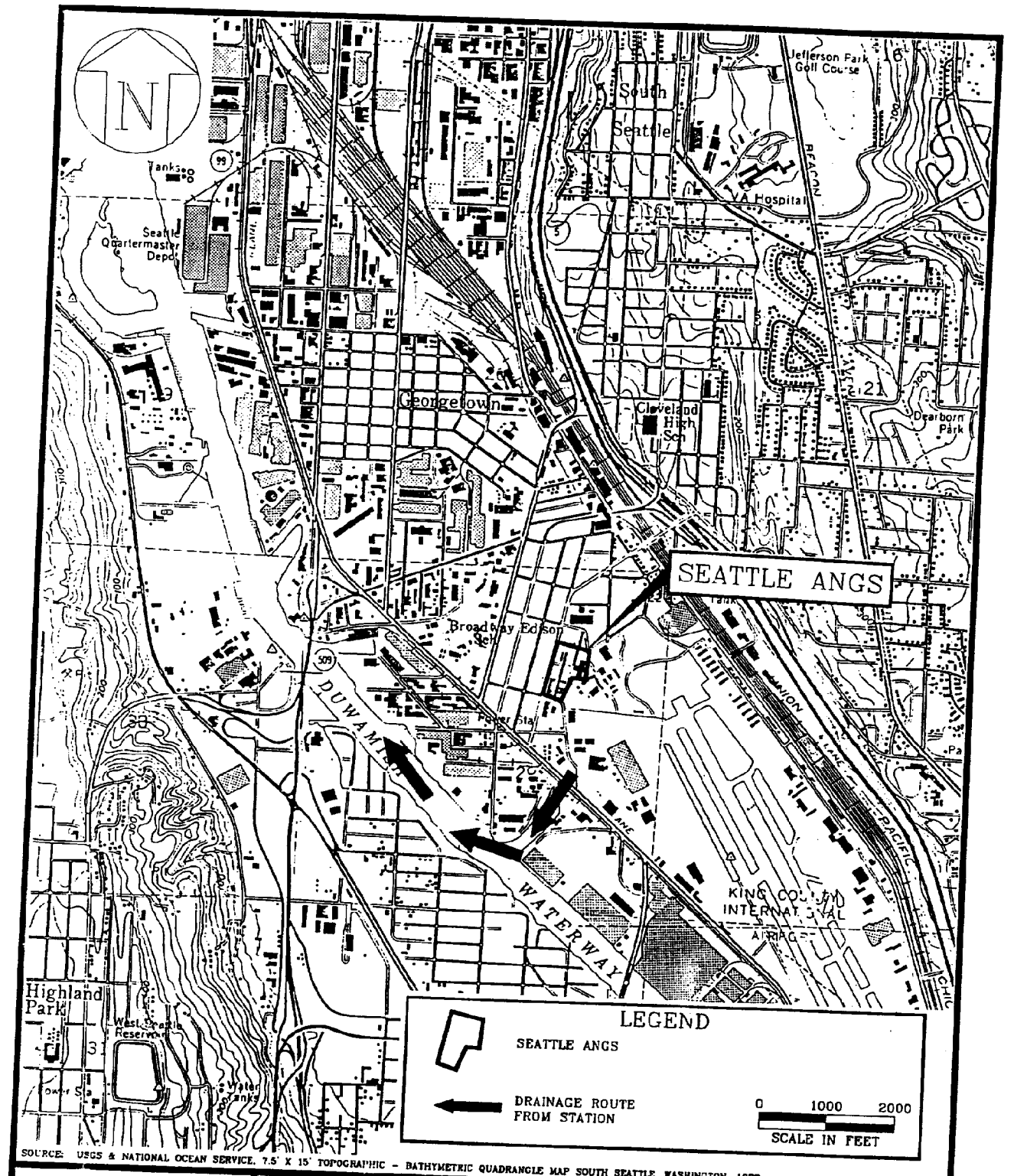

FIGURE 3.4

SEATTLE\SEA4-1LO

DRAINAGE PATTERN IN VICINTY OF SEATTLE ANGS
143rd CCSQ, Seattle ANGS
Seattle, Washington

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downstream of the station the Duwamish discharges into Elliot Bay on the Puget Sound. The Seattle Water Department indicated the Duwamish Waterway is not used for drinking water and is the only fresh water downgradient of the station. Surface water drainage is totally controlled by man-made drainage systems which are routed into the municipal storm sewer. Figure 3.5 illustrates the storm drain systems on the station.

3.5 HYDROGEOLOGY

3.5.1 Regional Hydrogeology

Groundwater at shallow depths occurs at Seattle ANGS under water table conditions within the upper part of the recent river alluvium. Investigations have found that groundwater is influenced by seasonal precipitation and tidal fluctuations, and may exhibit a southern and/or northern trend.

Deeper groundwater is reported by Luzier (1963) beneath the river alluvium in the unconsolidated glacial deposits. Characteristics of the deeper groundwater aquifer are unknown, though groundwater probably flows toward the Duwamish Waterway and thus to Elliot Bay.

The Seattle Water Department indicated that no municipal wells were within four miles of the station, and records obtained from the Washington Department of Ecology (DOE) Water Resources Department revealed no private drinking water wells within a one-mile radius of the station. The surrounding population obtains drinking water from municipal water.

3.5.2 Local Hydrogeology

Groundwater was encountered at a depth of approximately 5 feet BLS in January 1982 and 11 feet BLS in October 1974 during station geotechnical investigations conducted by Hart Crowser and Associates, Inc. These measurement dates reflect the dry and wet seasons in the region. Several investigations undertaken by Seacor and Landau Associates, on behalf of Boeing at North Boeing Field, have found groundwater in the area to occur at shallow depths under normal water table conditions. Groundwater is generally encountered at depths between 4 and 10 feet BLS (Seacor, December 1992). Groundwater flow is generally to the west/southwest, toward the Duwamish Waterway, at a gradient of approximately 0.002 feet per foot. Data compiled from monitoring wells developed as a result of an investigation at North Boeing Field show that static water levels ranged from 7.53 to 10.00 feet in the immediate vicinity of the station (Seacor, February 1992). Another investigation conducted at North Boeing Field showed that

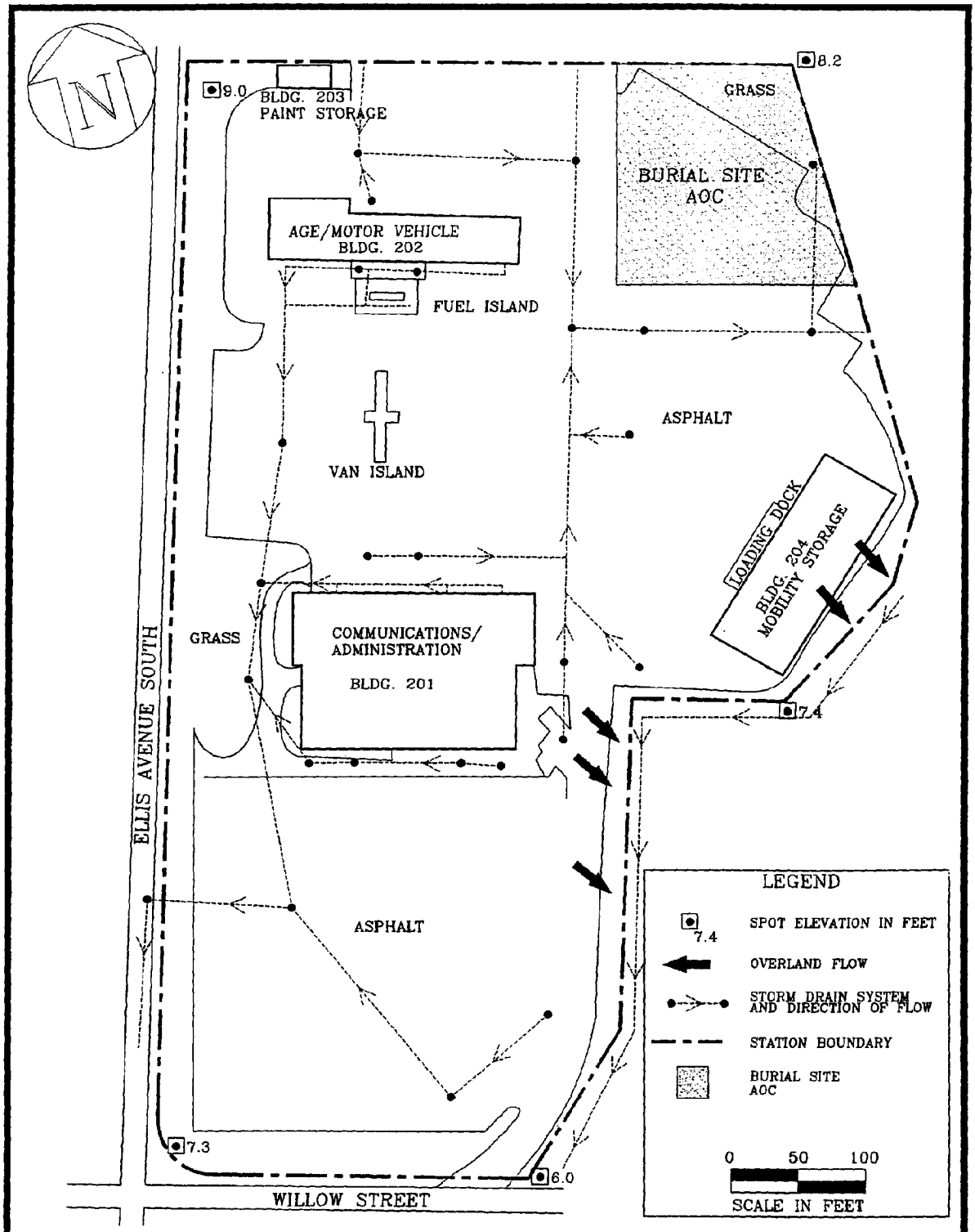

FIGURE 3.5

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SURFACE WATER DRAINAGE MAP
143rd CCSQ, Seattle ANGS
Seattle, Washington

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stabilized depth to groundwater in monitoring wells prior to sampling ranged from 6.95 to 8.74 feet (Seacor, September 1992).

3.6 CRITICAL HABITATS/ENDANGERED OR THREATENED SPECIES/WETLANDS

No critical habitats or endangered or threatened species have been identified within four miles of the site.

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Section 4

SECTION 4.0 SITE EVALUATION

4.1 ACTIVITY REVIEW

4.1.1 Preliminary Assessment Interviews

During the PA (1991), interviews were completed with four station personnel covering the period from 1972 to 1992, with an average of 16 years' tenure with the station (two people in Power Production, each with 20 years' tenure; and two people in Vehicle Maintenance, one with 11 years' tenure and the other with 14 years' tenure). These interviews confirmed past station operations involving the use and disposal of materials and wastes that were subsequently categorized as hazardous.

The interview process revealed a former waste burial site which is of concern due to historical practices of disposal of hazardous materials. In the early 1950s, various waste items were burned and/or buried in this area northeast of the old gravel parking lot (see Figure 2.3). This area is now the asphalt vehicle parking lot east of current Buildings 202 and 203 (see Figure 4.1). This burial site was used for the burning and burial of various waste items, which included radio tubes, solvents, waste oil, kerosene, batteries, brake fluid, spray paints, paint thinners and removers, methyl ethyl ketone (MEK), xylene, and naphtha. The practice of waste burial in this area ended by 1968.

4.1.2 Preliminary Assessment Records Search

As part of the PA (1991 and present) at Seattle ANGS, some station records were obtained. These records provided more detailed or corroborating information about the station in general. The following records were obtained:

- The Seattle ANGS Master Plan, including a current station map, current water/sewer/storm drainage systems map, and current electrical/gas systems map;
- Pertinent information and records on hazardous materials use and hazardous waste generation and disposal at the station;
- Available geologic, hydrologic, meteorologic, and environmental data from pertinent Federal, State, and local agencies; and

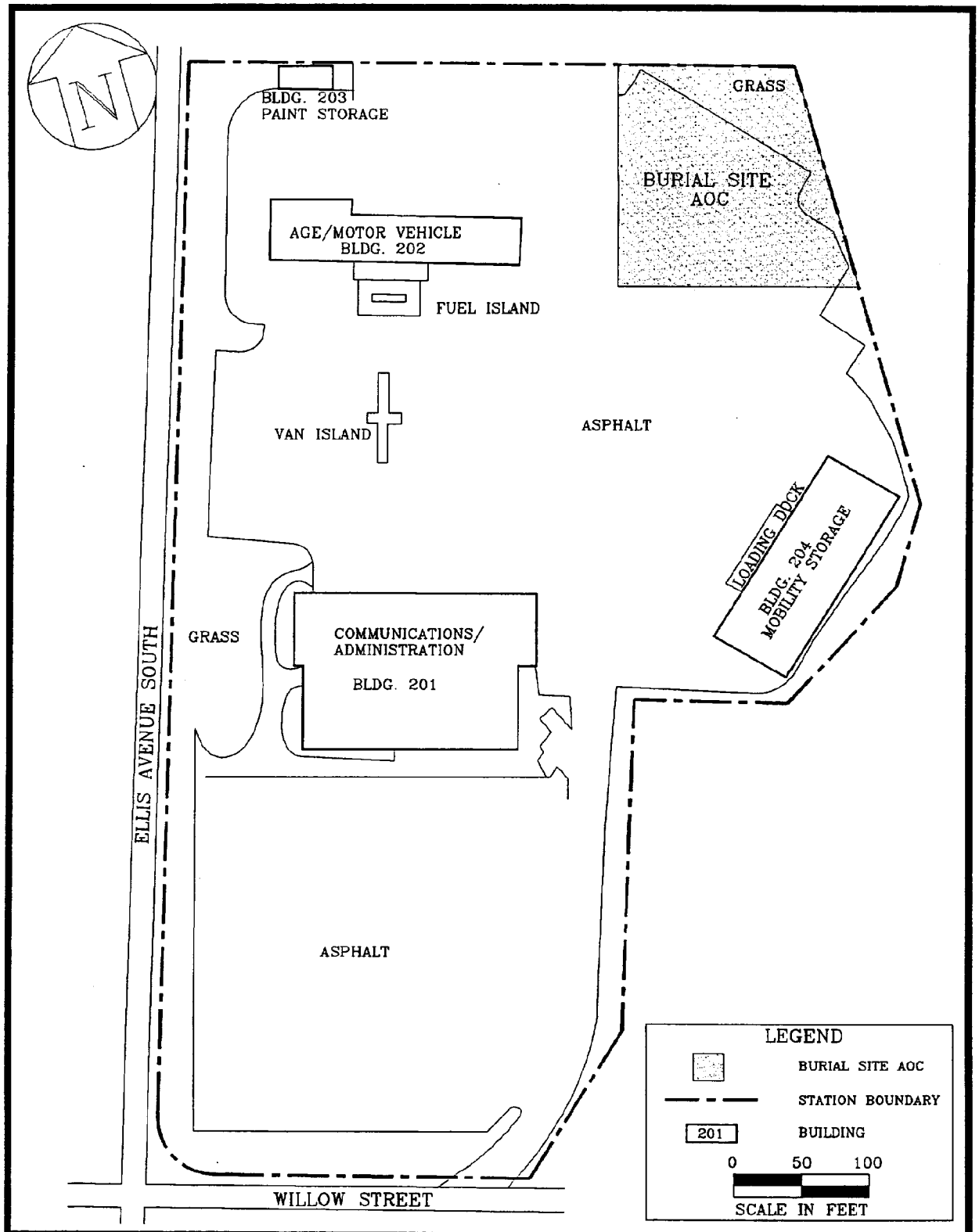

FIGURE 4.1

SEATTLE\SEA1-2SE

LOCATION OF AOC MAP
143rd CCSQ, Seattle ANGS
Seattle, Washington

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- Previous environmental investigations at the station, including soil boring logs and investigation data and conclusions.

- Two aerial photographs of the station and surrounding area dated March 10, 1970 and August 6, 1981.

- "As-built" station drawings dated April 30, 1982.

Except for an aerial photograph (of very poor resolution) of the general area taken in 1940, no site plans or photographs depicting the station layout and its activities during the World War II period were available.

4.1.3 Hazardous Materials Inventory

Seattle ANGS activities which generate waste oils, cleaning solvents, paint wastes, and thinners are conducted at the following locations: AGE/Motor Vehicle Maintenance, Power Production, and Communications/Administration. In the past, small amounts of hazardous materials have been spilled or released into the environment at the station. However, during recent years, hazardous wastes have typically been collected and disposed by a contractor or through the Defense Reutilization and Marketing Office (DRMO) at Fort Lewis, Washington. The historical disposition of these waste materials is shown in Table 4.1. Based on the information gathered, any operations not listed on Table 4.1 have been determined to produce negligible quantities of wastes.

4.2 DISPOSAL/SPILL AREA OF CONCERN IDENTIFICATION

4.2.1 Burial Site AOC

4.2.1.1 Background and Operational History

The Burial Site AOC is located in the northeast corner of Seattle ANGS, approximately 70 feet east of Building 202, the AGE/Vehicle Maintenance Building (see Figure 4.1). The site measures approximately 150 feet in length with an average width of 150 feet. A 6-foot-high security fence bounds the site to the north and east. The majority of the site is covered with asphalt and used for vehicle parking, with the exception of the northeast corner, which is covered with grass.

Table 4.1
Inventory of Hazardous Materials Used at Seattle ANGS
143rd CCSQ, Seattle ANGS, Seattle, Washington

Shop	Possible Waste Materials	Quantities Disposed (Gals/year)	Methods of Treatment, Storage, and Disposal in Chronological Order				
			1950s	1960s	1970s	1980s	Present
Power Production	Engine Oil	300	GRND	GRND	GRND	CIV	CIV
	MEK	5	GRND	GRND	GRND	GRND/DRMO	DRMO
	Gasoline	40–5[a]	GRND	GRND	GRND	GRND/DRMO/CIV	DRMO
	Paint Stripper/Thinner	30	GRND	GRND	GRND	GRND/DRMO	DRMO
	Spray Paint Containers	30 ea.	LDFL	LDFL	LDFL	LDFL	LDFL
	Radio Tubes	UNK	DUMP	DUMP	LDFL	NA	NA
Vehicle Maintenance	Engine Oil	400	GRND	GRND	GRND	GRND/CIV	CIV
	Sulfuric Acid	5	SAN	SAN	SAN	SAN/DRMO	DRMO
	Ethylene Glycol	50	GRND	GRND	GRND	SAN	CIV
	Transmission Fluid	15	GRND	GRND	GRND	GRND	CIV
	Grease (Bearing)	5	GRND	GRND	GRND	LDFL	LDFL/CIV
	Paint Thinner	25	GRND	GRND	GRND	GRND/DRMO	DRMO
Air Conditioning/ Refrigeration	Refrigeration Oil	10	GRND	GRND	GRND	GRND	GRND/CIV
Battery	Battery Acid	60	SAN	SAN	SAN	SAN/DRMO	DRMO/CIV
	Used Batteries	20 ea.	DRMO	DRMO	DRMO	DRMO	DRMO/CIV
Fuels Management	MOGAS	50–10[a]	GRND	GRND	GRND	GRND/DRMO/CIV	DRMO/CIV
	Diesel Fuel	100–15[a]	GRND	GRND	GRND	GRND/CIV	CIV

CIV – Disposed of through civilian contractor.
SAN – Disposed of in drains leading to sanitary sewer.
GRND – Disposed of on the ground.
LDFL – Disposed of in landfill off-site.
MOGAS – Motor vehicle gasoline.
[a]From 1940s to 1990s.

DRMO – Directly to the Defense Reutilization and Marketing Office.
DUMP – Disposed of at dump site.
UNK – Unknown.
MEK – Methyl ethyl ketone.
Gals. – Gallons.
NA – Not Applicable.

From the early 1950s to 1968, various waste items were burned and buried in the area northeast of the old gravel parking lot. The probable wastes associated with this site include radio tubes, solvents, waste motor oils, kerosene, batteries, brake fluid, spray paints, paint thinners and removers, MEK, xylene, and naphtha.

4.2.1.2 Review of Existing Sampling Data

No previous sampling data exists for this AOC.

4.3 OTHER PERTINENT FINDINGS

Other pertinent information identified during the PA (1991) interview process included the fact that all former underground storage tanks (USTs) previously located on-site were removed when the former buildings were demolished and the new facilities constructed in 1984. According to a station plan dated 1982, there were four USTs previously located at the station: a 4,000-gallon motor gasoline (MOGAS) UST, a 2,000-gallon diesel fuel UST, a 2,000-gallon UST (contents unknown), and a fourth UST (size and contents unknown). The location of these former USTs is shown in Figure 2.3. An inventory of Seattle ANGS USTs is included in Table 4.2.

Table 4.2
UST Inventory
143rd CCSQ, Seattle ANGS, Seattle, Washington

Tank No.	Contents	Capacity (gallons)	Construction Material	Status	Year Installed	External Protection
202-1	MOGAS	5,000	Steel	Active	1983	Cathodic
202-2	Diesel Fuel	5,000	Steel	Active	1983	Cathodic
202-3	Diesel Fuel	5,000	Steel	Active	1983	Cathodic
202-4	Used Oil	550	Steel	Active	1983	Paint
202-5	Oil/Water Separator	720	Concrete	Active	1983	Paint
UNK	Diesel	2,000	UNK	Removed 1983	UNK	UNK
UNK	MOGAS	4,000	UNK	Removed 1983	UNK	UNK
UNK	UNK	2,000	UNK	Removed 1983	UNK	UNK
UNK	UNK	UNK	UNK	Removed 1983	UNK	UNK

MOGAS – Motor gasoline. UNK – Unknown.

The four USTs currently located at the station (two 5,000-gallon USTs containing diesel fuel, one 5,000-gallon UST containing MOGAS, and one 550-gallon used oil UST) are approximately ten years old and are scheduled to be replaced by aboveground tanks in 1994. An oil/water separator is also located in the washrack area. The location of these USTs is shown in Figure 4.1. All USTs are inventoried monthly, and an annual tightness test is conducted. The Seattle ANGS has not experienced any known leaks in these USTs.

4.3.1 Surrounding Property Environmental History

The adjacent properties on three sides of Seattle ANGS are zoned for general industrial use, are currently used for industrial purposes, and have a history of industrial use. The properties directly east, southeast and southwest of the station are either owned by the Boeing Company (Boeing) or leased by Boeing from King County. The property immediately north of the station is utilized by several large trucking firms and the State of Washington auto maintenance facility, while the area west/northwest of the station, across Ellis Avenue South, consists of residential properties (see Figure 4.2).

A former power plant owned by Seattle City Light, which is currently vacant, is located approximately 200 feet northeast of the Seattle ANGS, adjacent to the Boeing property. This power plant was constructed in the 1890s and apparently used both coal and fuel oil in its operation. A 1946 aerial photograph interpretation shows a railroad spur, several large coal piles, and a large fuel oil tank in close proximity to the former power plant (Landau Associates, Inc., 1992). The large fuel oil tank (demolished in 1987) and the former coal piles were located upgradient from the Seattle ANGS, approximately 550 feet and 600 feet, respectively (see Figure 4.2).

A former fire-training area (FTA), the North Boeing Field Fire Training Center, was also located in close proximity to the former power plant. The former FTA, located approximately 550 feet upgradient (east) of the Seattle ANGS, was originally constructed in 1960. The FTA consisted of a rectangular-shaped earthen impoundment measuring approximately 140 feet by 100 feet and was used for fire-training exercises until late 1991 (see Figure 4.2). An investigation of the FTA was conducted by Landau Associates in July 1992. Soil sampling determined that, while petroleum hydrocarbon levels in some soil samples exceeded State cleanup levels, the impacts are limited to the boundaries of the fire-training pit and an area near the catchment basins designed to contain runoff from training activities. Analyses of groundwater samples detected several metals at concentrations well below cleanup levels, except for arsenic at 9 micrograms per liter (μg/L) in well MW-3 and at 11 μg/L in well MW-4 (the cleanup level

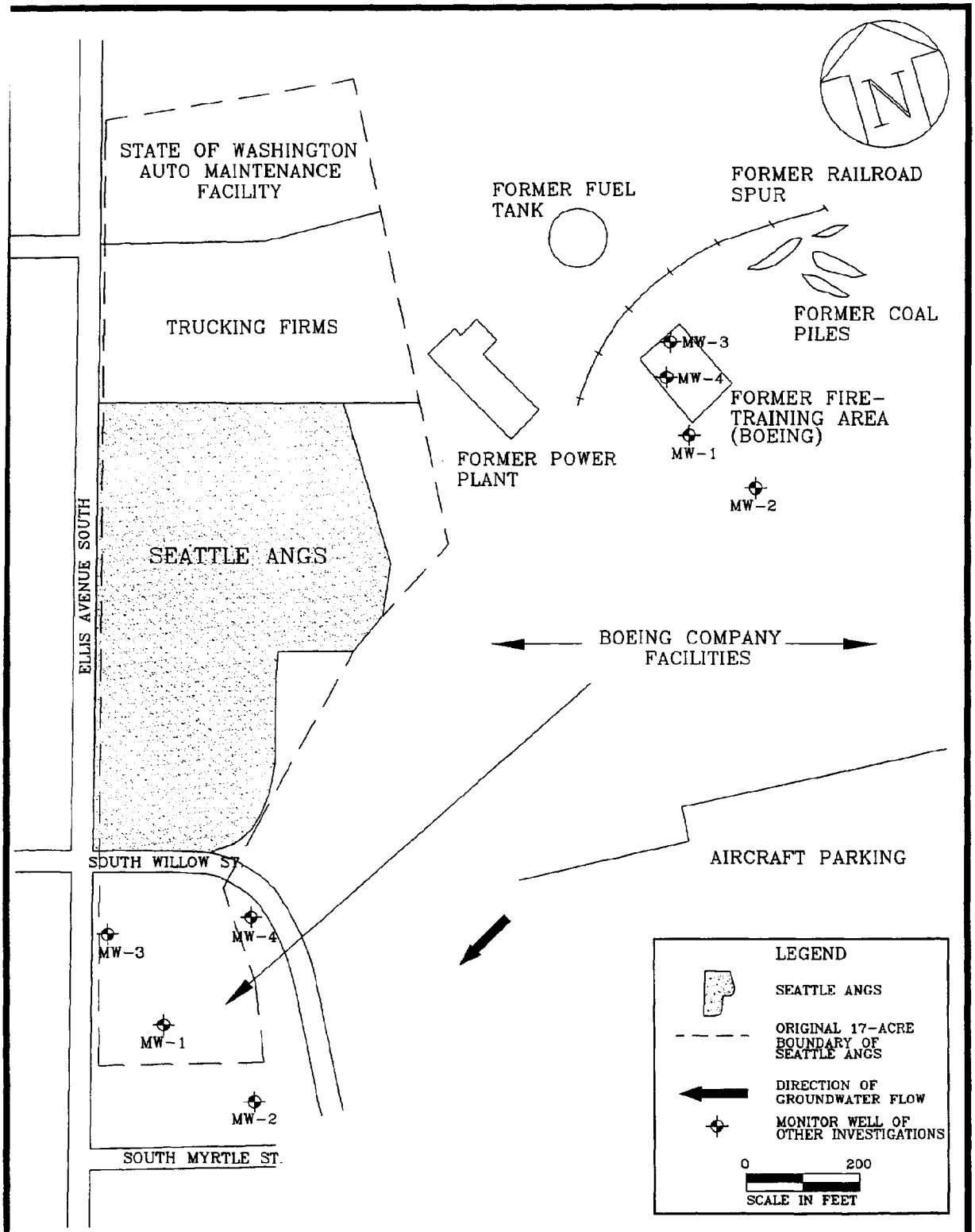

FIGURE 4.2

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AREAS OF ENVIRONMENTAL CONCERN IN VICINITY OF SEATTLE ANGS

143rd CCSQ, Seattle ANGS

Seattle, Washington

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for arsenic is 5 μg/L). Based on the low concentrations of arsenic detected, and the pattern of distribution, the occurrences of arsenic above cleanup levels appear to be more reflective of natural conditions, or of background concentrations in an industrialized area, rather than being attributable to a release from the site (Landau, October 1992).

A recent investigation conducted at North Boeing Field centered on the Boeing main fuel farm located approximately 2,500 feet southeast of the Seattle ANGS (Seacor, September 1992). This investigation revealed the presence of dissolved hydrocarbons in excess of cleanup levels in groundwater from several of the surrounding monitor wells. However, due to the fuel farm's location in relation to the station, groundwater from this site is not anticipated to impact station property.

Another investigation conducted by Seacor in February 1992 centered on a tract of Boeing property, bounded by South Willow Street to the north and South Myrtle Street to the south, adjacent to Seattle ANGS. Analysis of groundwater samples from four monitor wells on the tract detected total petroleum hydrocarbons (TPH) above action levels in two wells (1.4 mg/L in monitor well (MW)-1 and 4.6 milligrams per liter (mg/L) in MW-4), and trichloroethane above action levels in one monitor well (1,000 μg/L in MW-1). During investigations conducted in the North Boeing Field area, groundwater is typically encountered between 5 to 10 feet BLS, with groundwater flow direction being west/southwest toward the Duwamish Waterway.

4.4 CONCLUSIONS

The information obtained from the interviews and records search indicated that there is one AOC at Seattle ANGS, namely the Burial Site AOC. The location of this AOC is shown in Figure 4.1. This area was selected due to past practices involving the disposal of hazardous materials which could affect soil or groundwater at this location.

Due to the nature of both past and present activities conducted at sites surrounding the station, especially those upgradient from the station, the possibility that contaminants may have migrated onto station property cannot be discounted.

4.5 RECOMMENDATIONS

As a result of the PA (1991) activities performed at the Seattle ANGS, SI field activities were recommended at the AOC identified. The purpose of these activities was to confirm or deny the presence or suspected contamination in soils and groundwater at this AOC.

Section 5

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SECTION 5.0 FIELD PROGRAM

The purpose of the SI was to confirm or deny the presence of contamination at the Burial Site AOC identified in the PA (1991) at Seattle ANGS, and to provide data to reach a decision point for the AOC. This section describes the field activities performed during the SI to accomplish these objectives, and the methodologies used to conduct these activities. The SI at Seattle ANGS commenced on 5 July 1994 and was completed on 27 July 1994.

5.1 GENERAL APPROACH

The suspected mode of contamination at the Burial Site AOC was by intentional application (burial and surface burning) to the ground surface. Since the discontinuance of this practice in 1968, the majority of the land surface has been asphalted and used as a parking lot. Therefore, the preferred SI methods included a geophysical survey (ground-penetrating radar (GPR) and magnetometer) for detecting any evidence of burial activities, a soil vapor survey for initial screening, and the drilling of soil borings and piezometers for soil and groundwater sample collection. A summary of the screening and confirmation activities conducted at the Burial Site AOC is provided in Table 5.1.

Table 5.1
Burial Site AOC Site Inspection Summary
143rd CCSQ, Seattle ANGS, Seattle, Washington

Activity		Number and Type of Sample Locations	Number of Samples
Screening	Geophysical Survey	GPR 11 Horizontal and 11 Vertical Traverses	Continuous
		111 Magnetometer Locations	222
Confirmation	Soil Vapor Survey	21 Soil Vapor Points	21
	Soil Sampling	3 Soil Borings and 1 Piezometer Boring	10
	Groundwater Sampling	3 Piezometers	3

GPR – Ground-penetrating radar. AOC – Area of Concern.

The soil vapor survey was conducted prior to the drilling of soil borings and was used at the AOC as a screening tool for determining the optimum location of soil borings needed to confirm the absence or presence of soil contamination. Soil borings were drilled to determine soil background conditions, to screen for possible contamination, and to collect soil samples for laboratory analysis. Piezometers were drilled to determine station-wide groundwater flow

direction, to determine background groundwater quality, to screen groundwater for possible contamination, and to collect groundwater samples for laboratory analysis. As discussed in Subsection 3.5.2, groundwater is encountered from 4 to 10 feet BLS. Therefore, soil borings were planned for installation to a depth of 10 feet BLS or to the first encounterance of groundwater, and piezometers were planned for installation to a depth of 20 feet BLS, with a 10-foot screen from 9 to 19 feet BLS. The borehole logs are included in Appendix B and the piezometer construction diagrams are included in Appendix D.

5.2 FIELD SCREENING ACTIVITIES

Field screening activities conducted at the Seattle ANGS included a geophysical survey, a soil vapor survey, and field screening of soil and water samples collected for laboratory analytical confirmation.

5.2.1 Geophysical Survey

Two geophysical investigation techniques (GPR and magnetometer) were used in the SI at the AOC to detect the presence and location of subsurface metallic or non-metallic structures or anomalies.

Ground-penetrating radar is a geophysical survey technique that provides a continuous real-time cross-section of shallow subsurface conditions. The technique is suitable for locating buried non-metallic or metallic targets or structures. The GPR transmits a radar impulse downward into the ground. A portion of this signal is reflected at subsurface interfaces where electrical properties change significantly. The reflected radar signal is recorded as depth-dependent impulses on a scanning, time-based graphic chart recorder. Thus, towing the radar antenna along a traverse on the ground results in a cross-section depicting the longitudinal distribution of subsurface strata and other features over which the radar antenna has passed. The GPR survey was conducted using a Geophysical Survey Systems, Inc. Subsurface Interface Radar™ (SIR™) System 3 and a 300 megahertz (MHz) radar antenna. GPR survey results are discussed in Subsection 6.4.1.1.1. Complete GPR survey results are provided in Appendix C.

A dual-sensor magnetometer, referred to as a gradiometer, is a device which can locate buried ferrous metal objects. The magnetometer measures the intensity of the earth's magnetic field at the surface, and subsurface ferrous metal objects cause a detectable distortion of this magnetic field. Two sensors, spatially separated vertically by approximately 3 feet, are used to take two magnetic field readings at one location. Comparison of the two readings allows a gradient value

of the magnetic field to be calculated, thus removing regional magnetic effects and diurnal variance of the field. The gradient results obtained over a regular grid and analyzed together can define the location of buried ferrous metal anomalies. The magnetometer survey was conducted using a Geometrics 856-AG magnetometer with gradiometer option. Magnetometer survey results are discussed in Subsection 6.6.1.1.2. Complete magnetometer survey results are provided in Appendix C.

The geophysical survey data (GPR and magnetometer) obtained at Seattle ANGS was reviewed by a geophysical consultant for confirmation of the objectives of the geophysical screening activity of the Work Plan. This consulting service was provided by Dr. Thomas Dobecki of Dobecki Earth Sciences of Houston, Texas.

5.2.2 Soil Vapor Survey

Prior to installation of soil borings, a soil vapor survey was conducted at the AOC as a screening tool for developing the optimum soil boring locations needed to confirm the absence or presence of soil contamination. The soil vapor survey was conducted by Transglobal Environmental Geosciences Northwest, Inc., (TEG) of Lacey, Washington.

A probe, consisting of a 1-inch-diameter drive rod fitted with a vapor sampling point, was driven hydraulically to a depth of 2 to 5 feet BLS at each sampling location. Once the desired depth was achieved, the drive rod was pulled back slightly to expose the soil vapor sampling orifice on the point. Vapor was then drawn to the surface through 1/8-inch nylaflow tubing and collected, after discard of five dead volumes of the sampling chain, in a gas-tight syringe. Soil vapor samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) by modified United States Environmental Protection Agency (USEPA) Method 8020, as well as total volatile hydrocarbons (TVH) by modified USEPA Method 8015. These analyses were performed by TEG personnel using on-site gas chromatography equipment. A field duplicate soil vapor sample was collected at least every ten samples to provide a quality assurance check on analytical procedures. Based upon these in-field results, the Site Manager determined the locations of soil borings to be installed. Soil vapor survey data is discussed in Subsection 6.4.1.2. Complete soil vapor survey results are provided in Appendix A.

5.2.3 Field Screening of Confirmation Samples

Soil screening was performed during the field investigation at Seattle ANGS to provide immediate information as to the environment of the borehole, and to aid in the selection of soil samples to be submitted for laboratory analysis.

During sampling of soil borings, the air around the sampler was monitored with a Photovac MicroTip PID immediately upon opening the sampler (to maximize the detection of volatiles). The soil samples collected were placed in plastic bags, and the MicroTip PID was used to conduct ambient temperature headspace analysis (ATHA) for photoionization compounds. All PID and ATHA readings are provided on the boring logs included in Appendix B and are tabulated in Appendix C. Soil and groundwater samples were also field screened using a Photovac 10S50 Portable GC. The field GC, calibrated to screen for BTEX, was used to detect the presence of these compounds in the headspace from the soil samples collected. Data obtained from the field GC and PID supplements analytical laboratory data. Field GC data is summarized in Subsection 6.4.1.3. All field GC screening results are presented in Appendix C.

5.3 CONFIRMATION ACTIVITIES

Cascade Drilling, Inc., of Woodenville, Washington, was retained as the drilling contractor for all hollow-stem auger (HSA) activities. The selected drilling contractor mobilized personnel and equipment that met or exceeded Washington ANG and/or Washington DOE requirements.

AnalySys, Inc., of Austin, Texas, was retained to perform laboratory analyses. This laboratory is accredited by the Washington DOE to perform all analyses for this SI. Provisions were made for proper sample containers, labels, chain-of-custody forms, sample stabilization and preservation, and packing materials by the selected laboratory.

Meredith, Inc., of Bellevue, Washington, was retained as the surveying contractor. Station buildings adjacent to the AOC and soil boring and piezometer locations at the AOC were surveyed. The land surface elevation of each borehole and piezometer is shown on the soil boring logs in Appendix B.

5.3.1 Soil Sampling Activities

Soil borings were drilled to obtain soil samples for laboratory analysis to confirm or deny the presence of subsurface soil contamination. Soil samples were also used for determining site geology and subsurface soil characteristics.

A total of three soil borings were installed for data collection. All work was performed in a manner consistent with Washington DOE requirements. All borings were completed using HSA methods. All soil boring locations and elevations were determined by the surveyor contracted for Seattle ANGS field work.

5.3.1.1 Drilling Using Hollow-Stem Auger Methods

Three soil borings were completed by the driller using HSA methods at the AOC at Seattle ANGS. The HSA drilling method employs a hollow helical steel drill tool that is rotated to advance the boring and lift formation materials (cuttings) to the surface. The flights for the HSA are welded onto steel pipe and a cutter head is attached to the "lead" (bottom) auger to cut the hole. During drilling, a center bit is inserted into the hollow area of the cutter head that prevents cuttings from re-entering the hollow portion of the auger. Generally, the center bit is flush with or extends no more than 1/2 foot below the cutter head. The center bit connects through the auger flights by small diameter drill rods and is attached to the top-head drive unit of the drill rig. The top-head drive is powered by a truck-mounted engine that mechanically rotates the entire flight of augers. The hollow opening allows the insertion of sampling tools (i.e., split-spoon sampler) with the augers in place to prevent caving of the borehole.

Three soil samples were collected for subsurface characterization and field screening from each borehole installed by HSA methods. The first sample was collected from immediately below the surface, while the third was collected from the bottom of the borehole. The second sample was collected from elsewhere in each borehole, with its selection based on field screening results. A carbon steel California-style sampler equipped with three 6-inch brass sleeves was used for collecting soil samples for laboratory analysis. Actual sample depths submitted for laboratory analysis are discussed in Subsection 6.4.2 and shown on the soil boring logs included in Appendix B. The California-style sampler was decontaminated and new brass sleeves inserted before each sampling event. Auger flights, drill rig(s), and tools were thoroughly steam-cleaned in the designated decontamination area, located in the parking lot adjacent to the AOC, before initial use and after the completion of each borehole.

Borehole abandonment activities conformed to applicable State of Washington requirements. All HSA borings were backfilled with grout after sampling was accomplished to prevent the downward migration of contaminants through the open borehole.

5.3.2 Piezometer Installation

Piezometers were used to obtain water level data for hydrogeologic characterization of the aquifer, and to identify the presence of groundwater contamination. Three piezometers were drilled in the immediate vicinity of the Burial Site AOC at Seattle ANGS. All piezometer ground and top-of-casing elevations were determined by the surveyor contracted for the Seattle ANGS field work.

Piezometers were installed by the driller using HSA methods. Soil samples were collected at each 5-foot interval for geologic classification and field screening for contaminants. Auger flights were thoroughly steam-cleaned in the decontamination area, before initial use and after the completion of each piezometer. Likewise, all casing and screens installed in piezometers were thoroughly steam-cleaned before placement in the wellbore.

The piezometers were drilled by HSA methods to various depths. All three wells were drilled to 20.5 feet BLS. The piezometers were constructed of 2-inch ID Schedule 40 polyvinyl chloride (PVC) casing and screen. A filter pack, consisting of 10-20 grade silica sand, was placed around each screen to a point 2 feet above the top of the screen. A 5-foot bentonite pellet seal was placed above each filter pack and allowed to hydrate for a minimum of one hour. Above the bentonite seal, a cement grout was backfilled around the casings. All of the piezometers were completed as flush mounts. Piezometer construction diagrams are presented in Appendix D.

The static water level in each piezometer was measured using an oil/water interface probe. All piezometer coordinates, top-of-casing, and surface elevations were determined by the surveyor contracted for the Seattle ANGS field work. A single groundwater sample was collected from each piezometer a minimum of two days after piezometer development. Samples were obtained using a teflon bailer which was decontaminated between each sampling event. The bailer was rinsed once with sample water prior to sample collection.

5.3.3 Specific Media Sampling

This subsection summarizes the analytical program followed for soil, sediment, and surface water samples collected during the SI to determine the presence or absence of contamination at the Burial Site AOC at Seattle ANGS.

The Burial Site AOC was used for the burning and burial of various waste items which included radio tubes, solvents, waste oil, kerosene, batteries, brake fluid, spray paints, paint thinners and removers, MEK, xylene, and naphtha. Therefore, the analytical program of the PA/SI focused on the detection of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), priority pollutant metals, pesticides/polychlorinated biphenyls (PCBs), TPH, and gross alpha and beta radiation.

To comply with Washington DOE requirements, and to fulfill the requirements of the PA/SI, all soil and groundwater samples were analyzed for VOCs using Method SW8240; SVOCs using Method SW8270; priority pollutant metals by SW6010 and SW7000 series methods, pesticides/PCBs by Method SW8080, TPH by Washington TPH-Diesel and Washington TPH-Gasoline Methods, and gross alpha and beta radiation by Method SW9310. Table 5.2 summarizes the analytical program for all ten soil samples, as well as the three groundwater samples.

5.3.3.1 Soil Sample Packaging

All soil samples submitted for laboratory analysis collected with a split-barrel sampler or a California-style split-spoon sampler were contained in brass sleeves. Immediately upon removal from the sampler, the sleeve ends were covered with a Teflon™ barrier, aluminum foil, and fitted with a plastic cap. The sleeves were labeled, placed in plastic bags, stored in coolers, and chilled to 4° C or less.

5.3.3.2 Groundwater Sample Preservation

Each VOC water sample was stored in a 40-milliliter (mL) volatile organic analysis (VOA) vial with a Teflon™-lined lid and no airspace. The SVOC, pesticide/PCB, and TPH water samples were stored in separate 1-liter amber glass bottles having Teflon™-lined lids. The total recoverable metal water samples were stored in a 1-liter high-density polyethylene bottle with a Teflon™-lined lid. Gross alpha and beta samples were stored in 2-liter high-density polyethylene (HDPE) containers.

Table 5.2
Laboratory Analytical Program and Confirmation Activities Table
143rd CCSQ, Seattle ANGS, Seattle, Washington

AOC	Matrix	Field Methods	Lab Parameters	Methods	Investigative Samples
BS	Soil (Subsurface)	Field Screening using PID, Field GC, Soil Classification	VOCs SVOCs Metals PESTs/PCBs TPH Gross alpha and beta radiation	SW8240 SW8270 SW6010[a] SW8080 WTPH-G, WTPH-D SW9310	9
	Water (Subsurface)	Temperature, pH, Specific Conductance	VOCs SVOCs Metals PESTs/PCBs TPH Gross alpha and beta radiation	SW8240 SW8270 SW6010[a] SW8080 WTPH-D SW9310	2
BG	Soil (Subsurface)	Field Screening using PID, Field GC, Soil Classification	VOCs SVOCs Metals PESTs/PCBs TPH Gross alpha and beta radiation	SW8240 SW8270 SW6010[a] SW8080 WTPH-G, WTPH-D SW9310	1
	Water (Subsurface)	Temperature, pH, Specific Conductance	VOCs SVOCs Metals PESTs/PCBs TPH Gross alpha and beta radiation	SW8240 SW8270 SW6010[a] SW8080 WTPH-D SW9310	1

[a]All metals analyzed by SW6010 except: Arsenic – SW7060; Cadmium – SW7131; Chromium – SW7196; Lead – SW7421; Mercury – SW7470; Selenium – SW7740; and Thallium – SW7841.
TPH – Total Petroleum Hydrocarbons.
BS – Burial Site.
BG – Background.
SVOCs – Semivolatile Organic Compounds.
PESTs – Pesticides.
VOCs – Volatile Organic Compounds.
PCBs – Polychlorinated Biphenyls.
WTPH-G – Washington TPH-gasoline range (gas chromatography method).
AOC – Area of Concern.
WTPH-D – Washington TPH-diesel range (gas chromatography method).
PID – Photoionization Detector.
GC – Gas Chromatograph.

Each VOC sample was preserved with no more than two drops of a 1:1 solution of hydrochloric acid. The total recoverable metal samples were preserved with a solution of 1:1 nitric acid to achieve a pH level of less than 2. Gross alpha and beta samples were preserved with a solution of 1:1 nitric acid. SVOC, pesticide/PCB, and TPH samples required no preservatives.

5.4 DETERMINING BACKGROUND LEVELS

An evaluation of the significance of environmental contaminant concentrations is typically based on a comparison of the levels observed to known background conditions and regulatory-based standards, where applicable. Sampling of soil and groundwater at background locations was conducted to determine naturally-occurring concentration levels and contaminant or chemical concentrations already existing in the area due to general environmental conditions. Establishing soil and groundwater background conditions is necessary for risk assessment, establishing cleanup criteria, and making decisions on further site actions. The location chosen for background sampling was located away from any known or suspected station sources of contamination, and provided information on background conditions. Soil and groundwater samples, collected from piezometer BS-004PZ, serve as background data for the AOC under investigation.

5.5 BURIAL SITE AOC – SPECIFIC INSPECTION PROGRAM

The Burial Site AOC was used for the burning and burial of various waste items which included radio tubes, solvents, waste oil, kerosene, batteries, brake fluid, spray paints, paint thinners and removers, MEK, xylene, and naphtha. This SI is to determine if contamination has occurred at this location as the result of these past waste disposal activities.

5.5.1 Geophysical Survey

A geophysical survey of the Burial Site AOC was performed prior to the soil vapor survey or the installation of soil borings and piezometers. The survey employed GPR and magnetometer techniques for the detection of subsurface metallic or non-metallic structures or anomalies, or other evidence of burial activities, since the area is now covered with asphalt and grass. The survey was conducted over a 150-foot by 165-foot orthogonal grid with a spacing of 15 feet (see Figure 5.1). The radar was pulled along each of the horizontal and vertical traverses comprising the orthogonal grid.

The GPR was operated with a 300 MHz radar antenna. Using a two-way slowness value of 6 nanoseconds (ns) per foot (for saturated sand and silt), a range of 90 ns was chosen. Using a pulse width of 3 ns for the 300 MHz antenna, the cycles per scan was calculated to be 30. The high pass filter was then set at 70 cycles/scan and the low pass filter at 50 cycles/scan. With these settings, the resultant GPR trace suggested a penetration depth of approximately 10 feet was achieved.

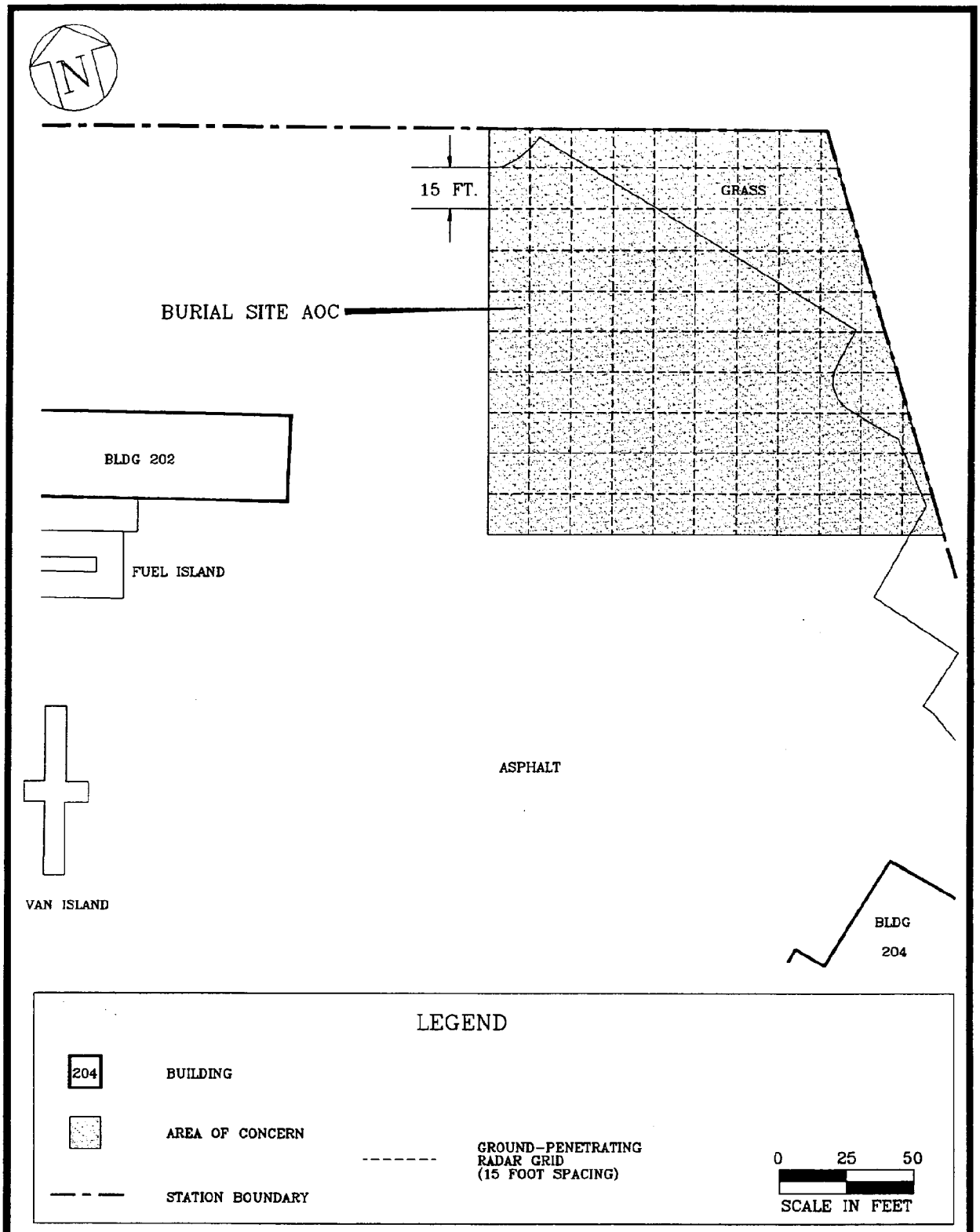

FIGURE 5.1

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BURIAL SITE AOC
GROUND-PENETRATING
RADAR SURVEY GRID
143rd CCSQ, Seattle ANGS
Seattle, Washington

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The magnetometer employed was a dual-sensor unit operated as a gradiometer. This mode of operation provides the best resolution for total magnetic field anomalies and is therefore most appropriate in searching for shallow subsurface ferrous metal objects. The survey involved the recording of gradient magnetometer readings at each intersection point of the grid laid out for the GPR survey (see Figure 5.2). The grid spacing in both directions was 15 feet, and the total size of the rectangular grid was 150 feet by 165 feet. In order to perform preliminary data reduction and analysis in the field using Geometrics-provided software, readings were required to be obtained at all points on the 150 by 165-foot grid. Because the survey area was not an exact rectangle, additional readings were taken along the eastern fence line to meet this requirement; these data were not employed in the final analysis.

Operators performing the magnetometer survey removed all ferrous metal objects from their bodies. Magnetic field readings obtained were generally on the order of 54,000 gauss. Sufficient signal strengths were usually obtained except in the immediate vicinity of surface interferences such as fences and light poles.

5.5.2 Soil Vapor Survey

Prior to installation of soil borings, a soil vapor survey was conducted at the Burial Site AOC to determine the optimum location of soil borings needed to confirm or deny the presence of contamination in soils associated with the hydrocarbon releases at this site. The locations of these soil vapor sampling points are shown in Figure 5.3. A total of 21 sample points were set up on a grid system with a distance of no more than 30 feet between sampling points. A soil vapor sample was collected from a depth of approximately 5 feet BLS from each location. Based upon these in-field results, the Site Manager determined the locations of soil borings to be installed. Soil vapor survey results are discussed in Subsection 6.4.1.2. The procedure for the soil vapor survey was described in Subsection 5.2.2.

5.5.3 Soil Boring Plan

The soil boring locations for the Burial Site AOC are shown in Figure 5.4. The exact locations were determined based on the results of the geophysical and soil vapor surveys for this AOC. Three HSA soil borings were drilled at this AOC. The soil borings were drilled in the area of past dumping, burning, and burial activities. Specifically, BS-001BH was located close to soil vapor location 5, at which toluene was detected in the soil vapor. BS-002BH was located between soil vapor locations 1 and 2, at which the highest TVH readings were detected in soil

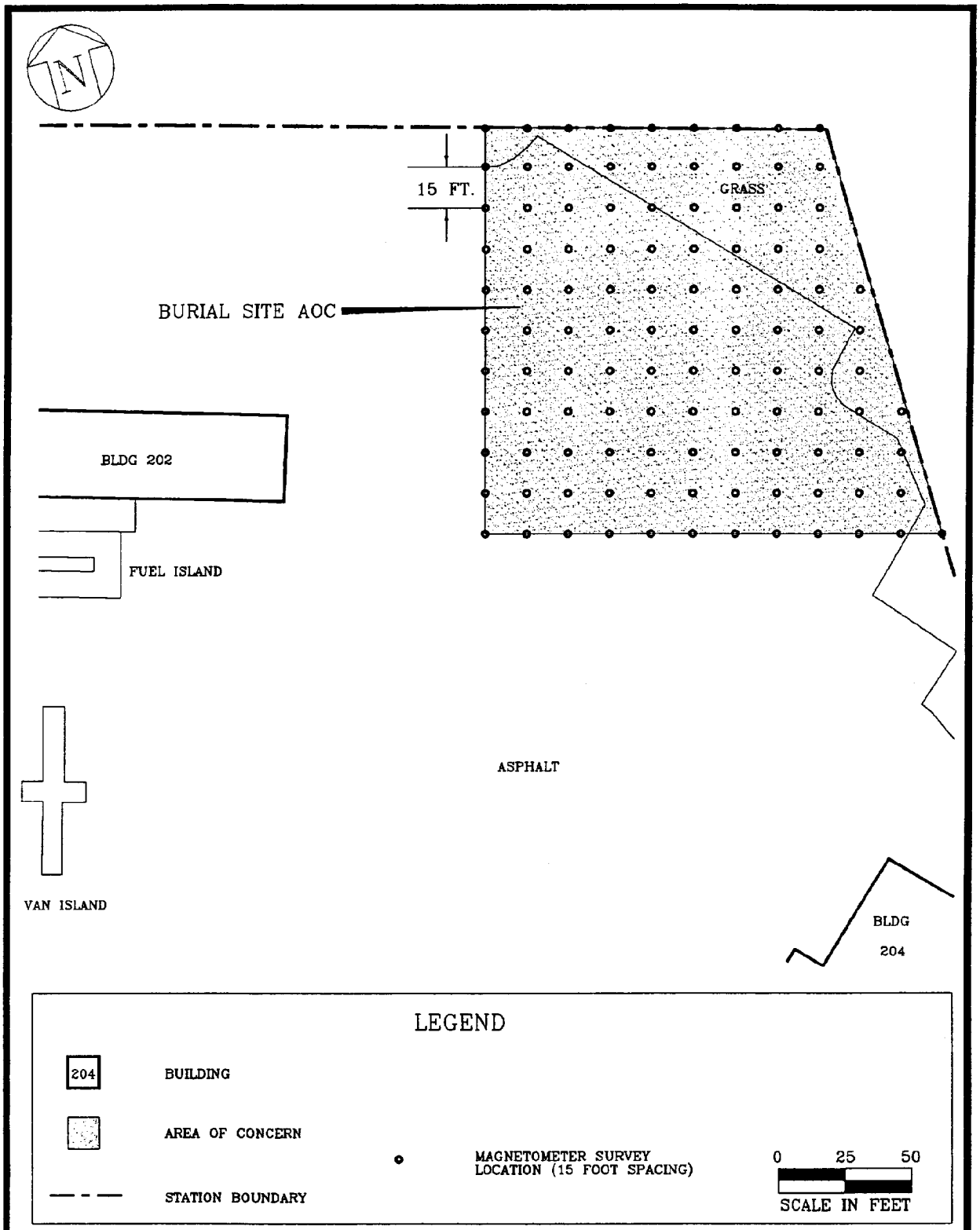

FIGURE 5.2

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BURIAL SITE AOC
MAGNETOMETER SURVEY
143rd CCSQ, Seattle ANGS
Seattle, Washington

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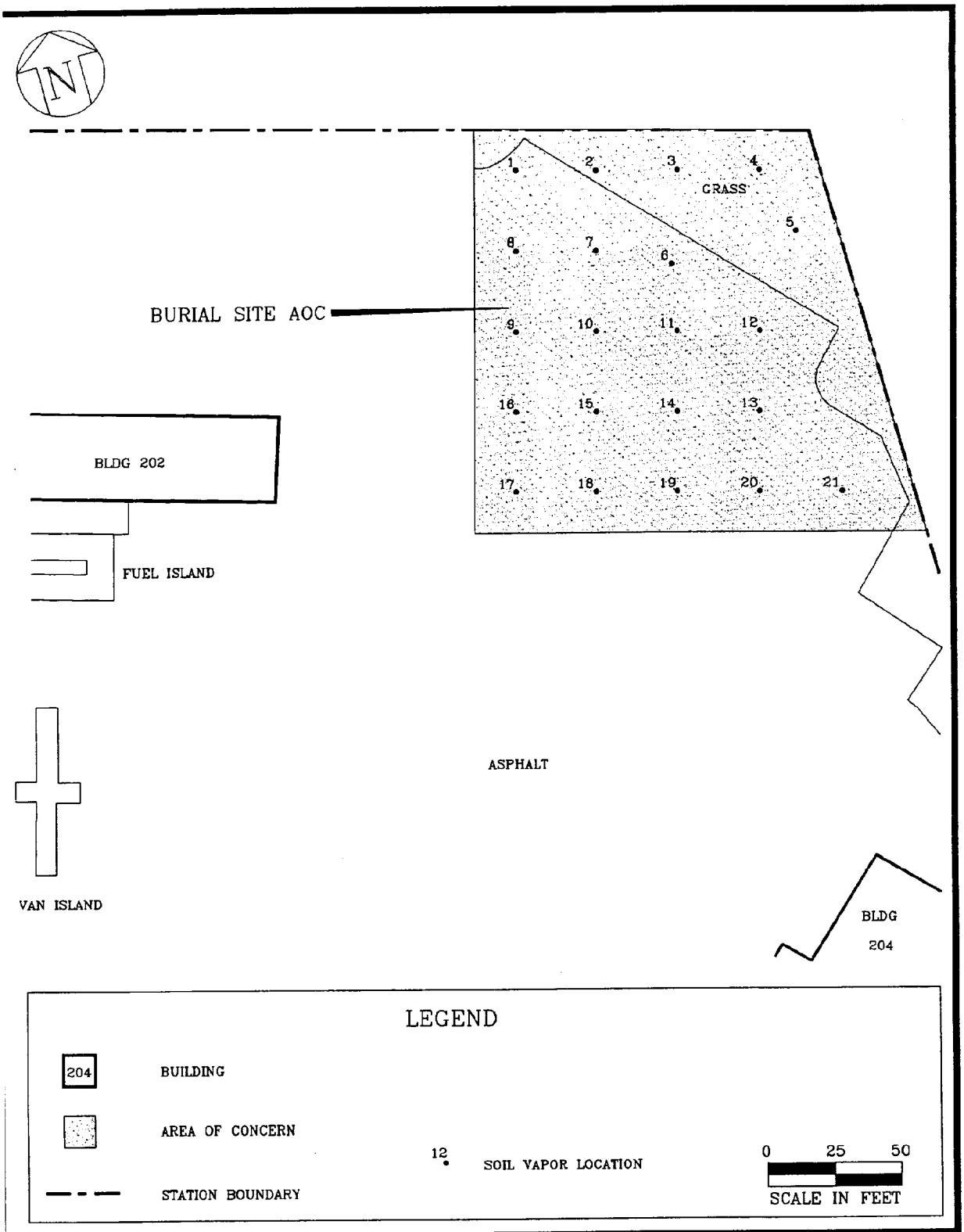

FIGURE 5.3

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BURIAL SITE AOC
SOIL VAPOR SURVEY
143rd CCSQ, Seattle ANGS
Seattle, Washington

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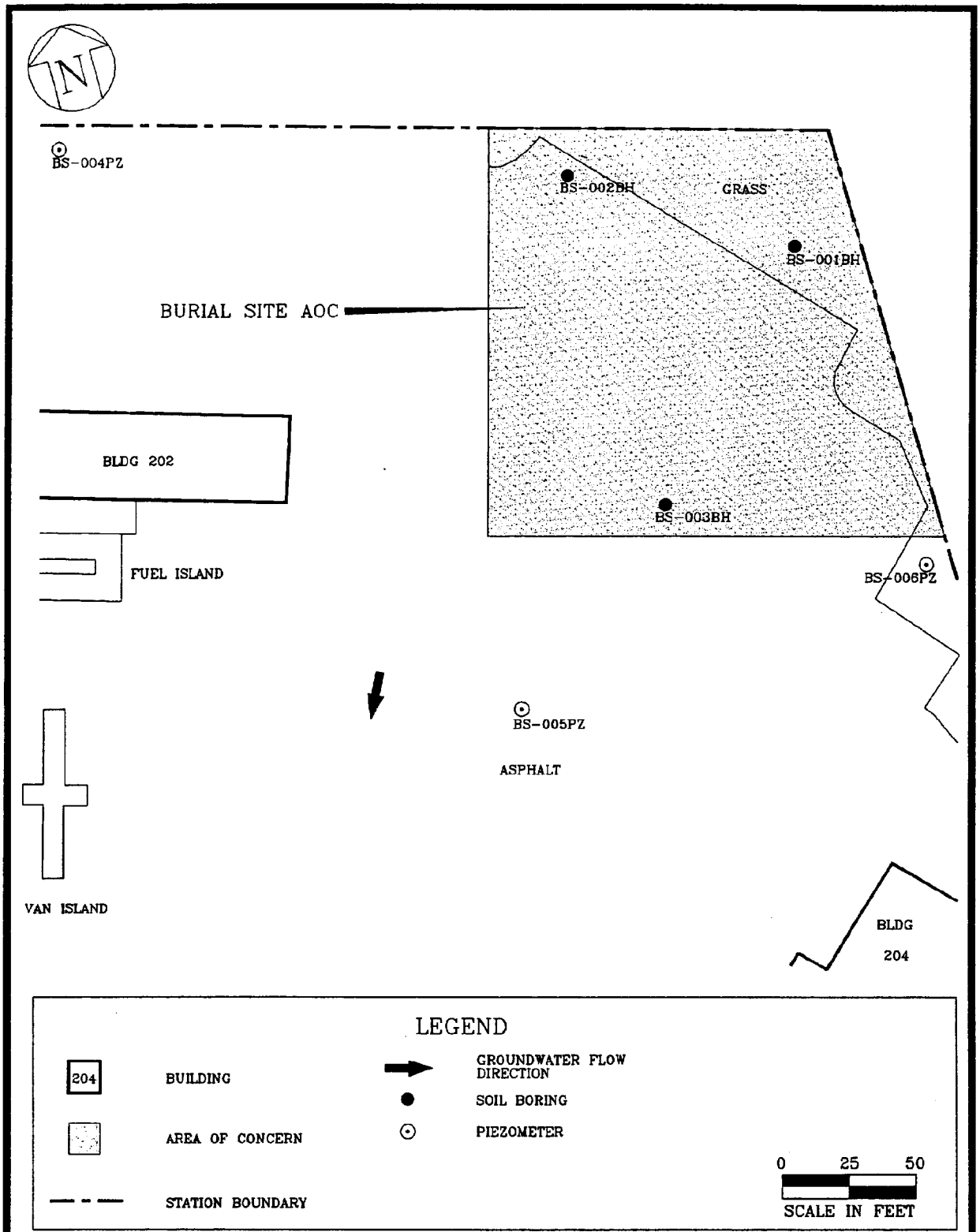

FIGURE 5.4

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BURIAL SITE AOC
SOIL BORING AND
PIEZOMETER LOCATIONS
143rd CCSQ, Seattle ANGS
Seattle, Washington

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vapor samples. Finally, BS-003BH was located adjacent to a large subsurface soil anomaly detected by the GPR survey.

5.5.4 Piezometer Plan

Three piezometers were drilled and sampled in the immediate vicinity of the Burial Site AOC. The locations of these piezometers are shown in Figure 5.4. Well BS-004PZ is located upgradient of the AOC, while the remaining piezometers are downgradient of the AOC. These locations were not changed from those proposed in the Work Plan. Soil and groundwater samples collected from piezometer BS-004PZ were used to establish soil and groundwater background conditions for this AOC.

5.6 SITE INSPECTION DERIVED WASTE

During the SI, a certain amount of waste material (drill cuttings and decontamination water) was produced as a result of investigation activities. Soil cuttings from drilling locations and all decontamination water were drummed in steel, plastic-lined 55-gallon Department of Transportation (DOT) drums. A total of 13 drums were produced; six containing soil cuttings, three containing decontamination water, three containing groundwater, and one containing brass sleeves. These drums are stored in the parking lot adjacent to the southeast corner of the grassy area of the AOC. There were no miscellaneous derived wastes (personal protective equipment (PPE) and Visqueen™ sheeting) which came in contact with soils having PID readings in excess of 100 parts per million (ppm); therefore, all PPE was discarded in a general refuse container at the conclusion of field work. All drums were properly marked to indicate their contents, including the collection date, contractor's name and phone number, and borehole identification number.

Guidance for final disposition of drummed materials is provided in the following subsections. Detailed information on the highest concentrations of analytes in drummed soil cuttings is given in Appendix H.

5.6.1 Drums Containing Soil

A total of six drums containing soil cuttings were produced during the SI. Table 5.3 lists the drilling locations for which drums have been marked "Soil," the recommended disposition of those drums, and the rationale for each recommendation.

Table 5.3
Recommended Disposition of Inspection Derived Waste
143rd CCSQ, Seattle ANGS, Seattle, Washington

Drum Number/ Material	Origin	Recommended Disposition	Rationale
1/Soil	BS-002BH	Dispose as a solid waste.	No analytes exceeded estimated TCLP regulatory levels.* Concentrations of analytes for which TCLP regulatory levels do not exist were equal to or less than site-specific background concentrations.
2/Soil	BS-001BH	Dispose as a solid waste.	No analytes exceeded estimated TCLP regulatory levels.* Concentrations of analytes for which TCLP regulatory levels do not exist were equal to or less than site-specific background concentrations.
3/Soil	BS-003BH	Dispose of in a landfill which accepts TPH contaminated soil or send to a soil recycler.	Analytical results show TPH significantly exceeds State action level.
4/Soil	BS-006PZ	Perform TPH analysis to determine whether TPH contamination is present.	Field GC screening of soils on-site indicated possible volatile contamination.
5/Water	Decontamination Water	Perform TPH and gross alpha radiation analysis to determine whether TPH and gross alpha contamination is present.	Potential contaminants contacted sampling equipment; TPH in soil samples and gross alpha in groundwater are the only contaminants which significantly exceed applicable action levels.
6/Soil	BS-005PZ	Perform TPH analysis to determine whether TPH contamination is present.	Field GC screening of soils on-site indicated possible volatile contamination.
7/Brass Sleeves	All Samples	Dispose of in a landfill which accepts TPH contaminated soil or send to a soil recycler.	Some brass sleeves were taken from soil samples whose results show TPH levels which significantly exceed State action levels.
8/Water	Decontamination Water	Perform TPH and gross alpha radiation analysis to determine whether TPH and gross alpha contamination is present.	Potential contaminants contacted sampling equipment; TPH in soil samples and gross alpha in groundwater are the only contaminants which significantly exceed applicable action levels.
9/Water	Decontamination Water	Perform TPH and gross alpha radiation analysis to determine whether TPH and gross alpha contamination is present.	Potential contaminants contacted sampling equipment; TPH in soil samples and gross alpha in groundwater are the only contaminants which significantly exceed applicable action levels.

Table 5.3 (Concluded)
Recommended Disposition of Inspection Derived Waste
143rd CCSQ, Seattle ANGS, Seattle, Washington

Drum Number/ Material	Origin	Recommended Disposition	Rationale
10/Soil	BS-004PZ	Dispose as a solid waste.	No analytes exceeded estimated TCLP regulatory levels.* Concentrations of analytes for which TCLP regulatory levels do not exist were equal to or less than site-specific background concentrations.
11/Water	BS-006PZ Develop & Purge	Determine whether the City of Seattle Wastewater Management will allow gross alpha-and gross beta-contaminated water to be disposed of in the sewer system.	Analytical results show gross alpha and gross beta radiation exceed State action levels.
12/Water	BS-005PZ Develop & Purge	Determine whether the City of Seattle Wastewater Management will allow gross beta-contaminated water to be disposed of in the sewer system.	Analytical results show gross beta radiation exceeds State action level.
13/Water	BS-004PZ Develop & Purge	Determine whether the City of Seattle Wastewater Management will allow gross alpha-and gross beta-contaminated water to be disposed of in the sewer system.	Analytical results show gross alpha and gross beta radiation exceed State action levels.

BG – Background.
BS – Burial Site AOC.
TPH – Total Petroleum Hydrocarbons.
TCLP – Toxicity Characteristic Leaching Procedure.
BH – Borehole.
GC – Gas Chromatograph.
PID – Photoionization Detector.
* – Estimated TCLP regulatory levels – analyte concentrations are compared to 20 times the TCLP regulatory level, which represents an estimate of the minimum concentration of the analyte which would have to be present in the soil for a TCLP analysis to lead to a positive result.

5.6.2 Drums Containing Non-Potable Water

Decontamination water was drummed separately. Table 5.3 includes the three drums marked "Decontamination Water," the recommended disposition of the drum, and the rationale for this recommendation.

Groundwater produced during development and purge activities at three piezometers was drummed separately. Table 5.3 includes the three drums marked "Water," the recommended disposition of the drums, and the rationale for this recommendation.

5.7 DEVIATIONS FROM THE WORK PLAN

There were no significant deviations from the Work Plan.

Section 6

SECTION 6.0 SITE INSPECTION RESULTS

6.1 BURIAL SITE AOC SUBSURFACE GEOLOGY

Soil samples collected from the soil borings and piezometers at the Burial Site AOC were used to provide information for description of the subsurface geology and soil conditions in the vicinity of the Burial Site AOC. Complete lithologic logs for the soil borings and piezometers drilled during this SI are presented in Appendix B. Sand, silty sand, and silty clay were the predominant materials encountered during the boring activities at the Burial Site AOC. A gravel and sand fill material was encountered in the first 1 to 2 feet BLS at all piezometer locations and at boring BS-003BH. At all three piezometer locations, a silty sand was then encountered to 10 feet BLS, followed by a well-sorted, coarse-grained sand from 10 to 20.5 feet BLS. For the three borings, the predominant materials encountered from the surface to 4 feet BLS were a silty sand and clay; a clayey sand; and fill and a clayey sand for borings BS-001BH, BS-002BH, and BS-003BH, respectively. From this depth to 10 feet BLS, silty sand was encountered in all borings, with a clayey sand interval encountered at 5.5 to 7 feet BLS in boring BS-001BH being the only exception. Cross-sections depicting the subsurface geology are indexed in Figure 6.1 and shown in Figures 6.2 and 6.3.

6.2 LABORATORY QUALITY ASSURANCE RESULTS FOR CONFIRMATION SAMPLES

The analytical efficiency of each and every laboratory analysis is validated by measuring the recovery of specific compounds which are spiked into all samples. Such compounds are known as surrogates. The recovery of surrogate compounds for an analytical procedure must fall within a range of control limit values for each analysis to be considered valid or compliant with the procedure.

VOC surrogate recoveries for ten soil samples ranged from 84% to 103% for 1,2-dichloroethane-d_2, from 92% to 98% for 4-bromofluorobenzene, and 107% to 116% for toluene-d_8. These surrogate recoveries for soil samples were all within quality control limits for all three surrogates. VOC surrogate recoveries for three groundwater samples ranged from 98% to 108% for 1,2-dichloroethane-d_2, from 96% to 97% for 4-bromofluorobenzene, and 95% to 98% for toluene-d_8. These surrogate recoveries for groundwater samples were all within quality control limits for all three surrogates. Therefore, all VOC analysis results are considered valid.

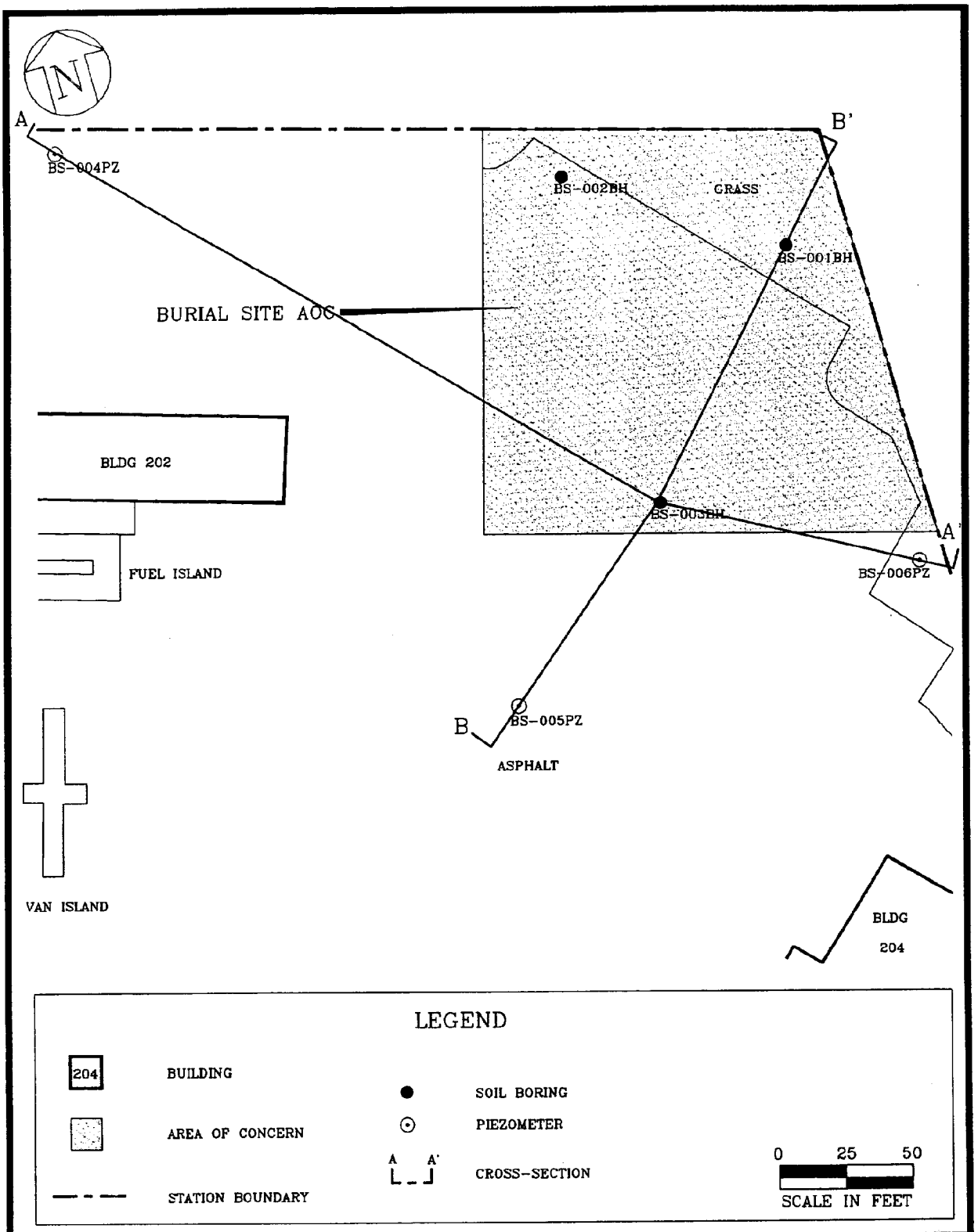

FIGURE 6.1

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GEOLOGIC CROSS-SECTION
LOCATION MAP
143rd CCSQ, Seattle ANGS
Seattle, Washington

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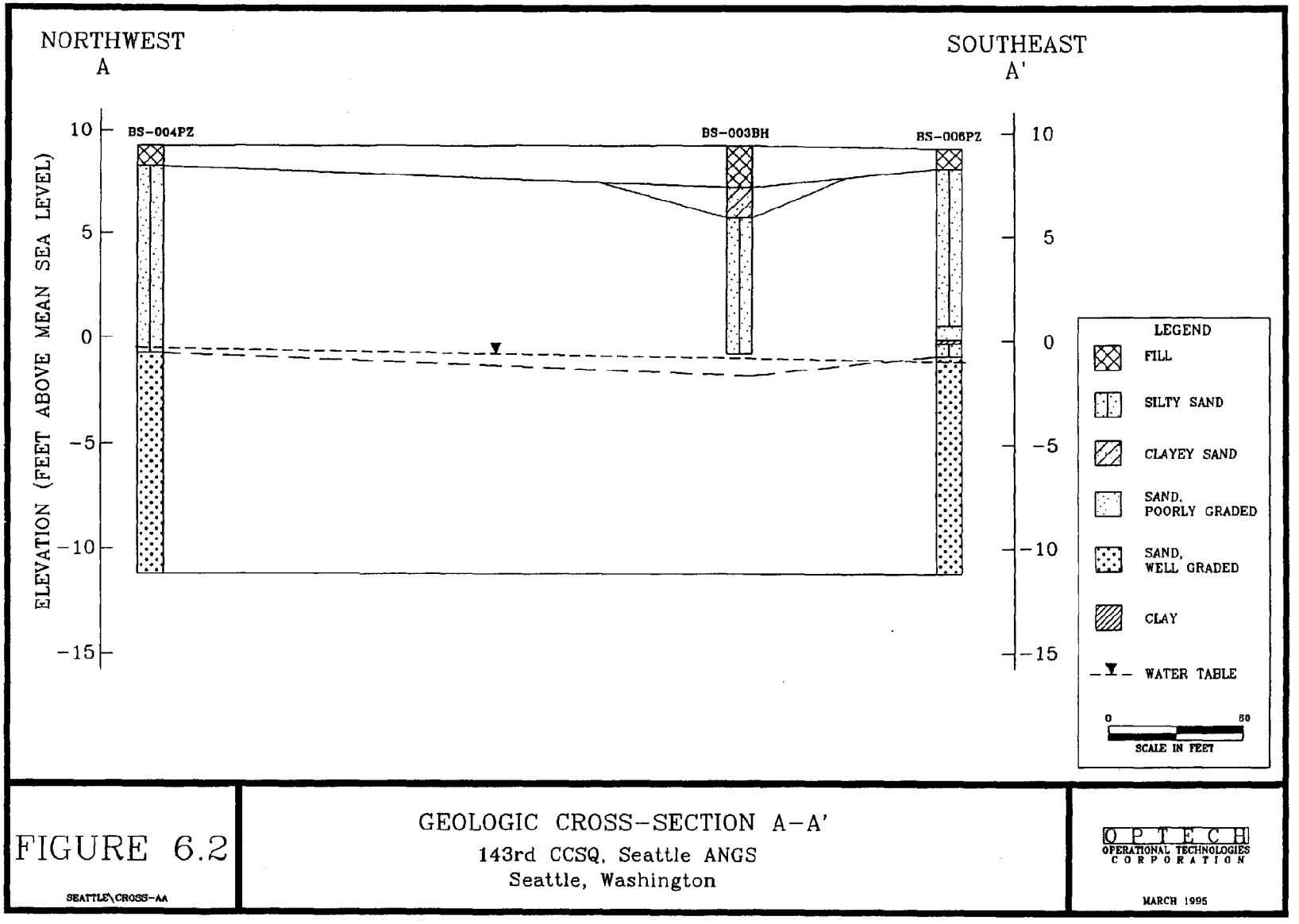

FIGURE 6.2

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GEOLOGIC CROSS-SECTION A-A'

143rd CCSQ, Seattle ANGS

Seattle, Washington

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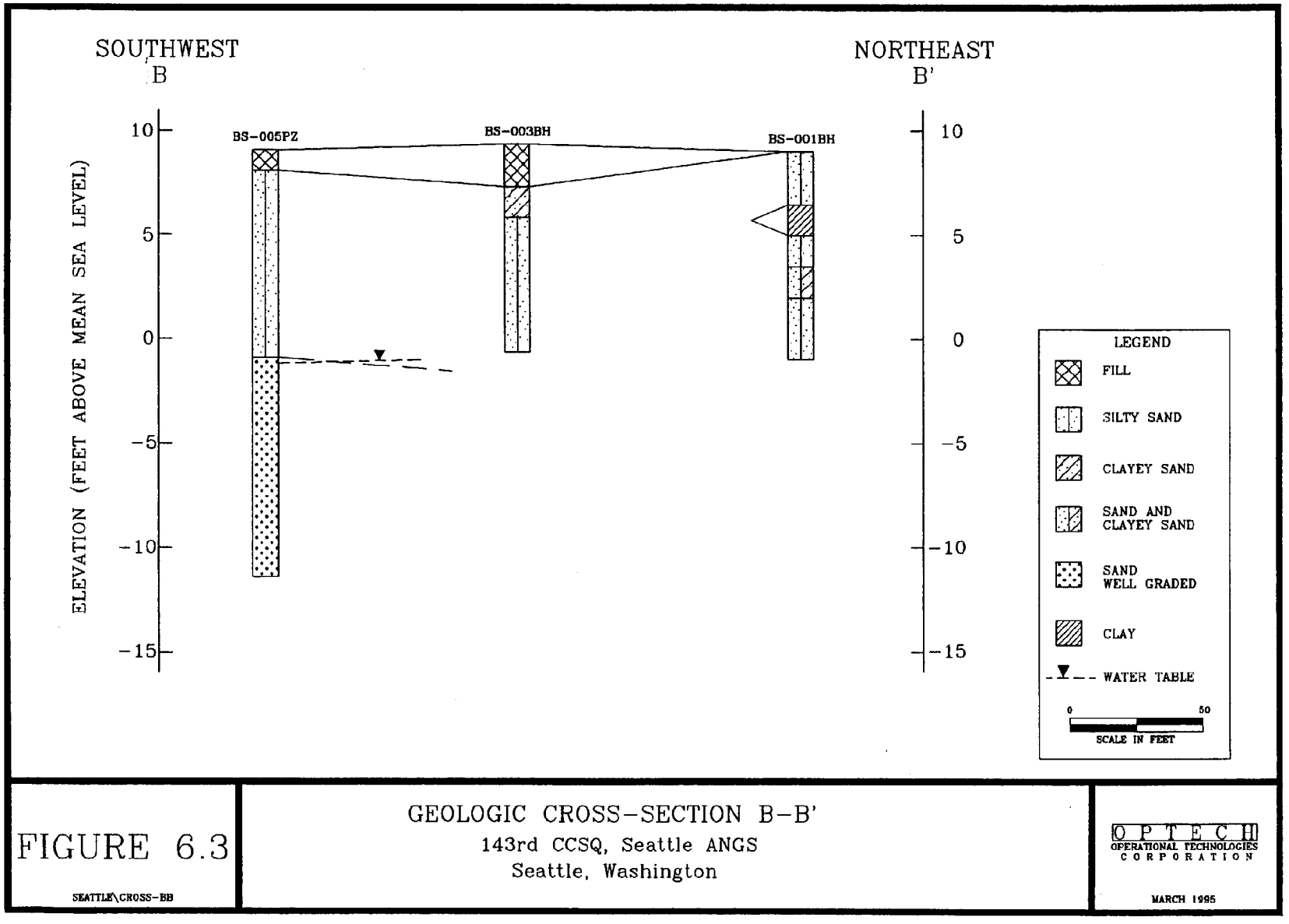

FIGURE 6.3

SEATTLE\CROSS-BB

GEOLOGIC CROSS-SECTION B-B'
143rd CCSQ, Seattle ANGS
Seattle, Washington

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SVOC surrogate recoveries for ten soil samples for acid compounds ranged from 4.2% to 63.1% for 2,4,6-tribromophenol, from 1.4% to 43.2% for 2-fluorophenol, and from 2.7% to 52.4% for phenol-d_5. SVOC surrogate recoveries for base-neutral compounds ranged from 3.1% to 51.1% for 2-fluorobiphenyl, from 3.0% to 44.2% for nitrobenzene-d_5, and from 43.2% to 70.6% for terphenyl-d_{14}. The quality control acceptance criteria for SVOC surrogate compounds allows for one acid and/or base-neutral compound to be outside of the specific recovery limits. This criteria was met on 7 of 10 soil samples analyzed, and therefore, these SVOC analysis results are considered valid. Two soil samples had surrogate compounds diluted out of quality control ranges because of matrix interferences in the sample. The remaining soil sample for which the quality control criteria was not met was BS-003BH (5.5 - 7.0 feet BLS). The only SVOC detected in this sample was di-n-butyl phthalate, whose presence in this sample is suspected to be due to laboratory contamination (USEPA, 1993).

SVOC surrogate recoveries for three groundwater samples for acid compounds ranged from 12.2% to 45.5% for 2,4,6-tribromophenol, from 36.1% to 45.6% for 2-fluorophenol, and from 31% to 52.3% for phenol-d_5. SVOC surrogate recoveries for base-neutral compounds ranged from 47.8% to 58.7% for 2-fluorobiphenyl, from 37.3% to 52.2% for nitrobenzene-d_5, and from 77.9% to 80.9% for terphenyl-d_{14}. The quality control acceptance criteria for SVOC surrogate compounds allows for one acid and/or base-neutral compound to be outside of the specific recovery limits. This criteria was met for all three groundwater samples analyzed, and therefore, these SVOC analysis results are considered valid.

Pesticide/PCB surrogate recoveries for ten soil samples ranged from 37.3% to 55.6% for 2,4,5,6-tetrachloro-m-xylene, and from 0.5% to 73.7% for dibutyl chlorendate. The quality control acceptance criteria for pesticide/PCB surrogate compounds are advisory limits only. This criteria was met for seven soil samples analyzed. Three soil samples had surrogate compounds diluted out of quality control ranges because of matrix interferences in the sample. Pesticide/PCB surrogate recoveries for three groundwater samples ranged from 48.6% to 52.9% for 2,4,5,6-tetrachloro-m-xylene, and from 0% to 127.4% for dibutyl chlorendate. The quality control acceptance criteria was met for all groundwater samples analyzed. Therefore, all pesticide/PCB analysis results are considered valid.

TPH surrogate recoveries for ten soil samples ranged from 61.3% to 81.2% for p-terphenyl (TPH-diesel) and from 79.2% to 100.3% for pentafluorobenzene (TPH-gasoline). The quality control acceptance criteria for the Washington State TPH methods has control limits of 50% to 150% recovery. All ten soil samples met this criteria. TPH surrogate recoveries for three groundwater samples ranged from 71.8% to 146.5% for p-terphenyl (TPH-diesel). The TPH

quality control acceptance criteria was met for all groundwater samples analyzed. Therefore, all TPH-diesel and TPH-gasoline analysis results are considered valid.

6.3 BACKGROUND FINDINGS

6.3.1 Background Sampling Locations

Background data at the 143rd CCSQ consisted of one piezometer, BS-004PZ, which was used to obtain both soil and groundwater samples. This location was selected because it is away from any known or suspected sources of contamination at the station, and is upgradient from the AOC.

6.3.2 Background Sampling Results

Soil and groundwater samples were collected for laboratory analysis from this background location to determine naturally-occurring concentration levels, and contaminant or chemical concentrations already existing in the area due to general environmental conditions. Analytical results obtained during this sampling represent background conditions against which contaminant concentrations detected at the site were compared and the significance of detected contamination determined.

6.3.2.1 Soil

Piezometer BS-004PZ was drilled to a depth of 20.5 feet. Groundwater was encountered at a depth of 10 feet BLS. One investigative soil sample was collected on 14 July 1994 for laboratory analysis. This sample was analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, and gross alpha and gross beta radiation.

Sampling depths and the analytical program are indicated in Table 6.1. A complete listing of the results for background samples is given in Appendix E.

No VOCs, TPH (diesel or gasoline range), or pesticides/PCBs were detected in the background soil sample.

Table 6.2 summarizes the SVOCs detected in samples collected from the background location. The SVOC di-n-butyl phthalate was detected at a concentration of 2,240 micrograms per

Table 6.1
Background Sampling and Analytical Program for the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Sample Location Number	Sample Depth (ft BLS)	Background Analyses and Methods					
		VOCs (SW8240)	SVOCs (SW8270)	Metals (SW6010†)	TPH (WTPH-D)	Pest/PCBs (SW8080)	Gross Alpha & Gross Beta (SW9310)
BS-004PZ	8.5 - 10.0	X	X	X	X*	X	X
BS-004PZ	NA	X	X	X	X	X	X

†All metals analyzed by SW6010 except: Arsenic – SW7060; Cadmium – SW7131; Chromium – SW7196; Lead – SW7421; Mercury – SW7470; Selenium – SW7740; and Thallium – SW7841.
AOC – Area of Concern.
ft BLS – feet Below Land Surface.
VOCs – Volatile Organic Compounds.
SVOCs – Semivolatile Organic Compounds.
TPH – Total Petroleum Hydrocarbons.
Pest/PCBs – Pesticides/Polychlorinated Biphenyls.
BS – Burial Site AOC.
PZ – Piezometer.
NA – Not Applicable.
X – Indicates parameter was analyzed.
WTPH-D – Washington TPH-diesel range (gas chromatography method).
* – Also analyzed for Washington TPH-gasoline range (gas chromatography method).

Table 6.2
Semivolatile Organic Compounds in Background Samples Collected at the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Sample Location Number	Sample Depth (ft BLS)	Semivolatile Organic Compound
		Di-n-butyl phthalate*
BS-004PZ (soil)	8.5 - 10.0	2,240 µg/kg
BS-004PZ (groundwater)	NA	10U µg/L

AOC – Area of Concern.
ft BLS – feet Below Land Surface.
µg/kg – micrograms per kilogram.
µg/L – micrograms per liter.
NA – Not Applicable.
BS – Burial Site AOC.
PZ – Piezometer.
U – Compound analyzed for but not detected. Number indicates the detection limit.
* – Common laboratory contaminant in SVOC analyses.

kilogram (µg/kg) in the background soil sample collected. This SVOC is a common laboratory contaminant (USEPA, 1993).

Table 6.3 summarizes the metals detected. Nine of the 13 priority pollutant metals analyzed were detected in this soil sample. Antimony, mercury, selenium, and silver were not reported above detection limits in the soil sample, while arsenic was detected at 2 milligrams per kilogram (mg/kg), beryllium at 1.2 mg/kg, cadmium at 1.6 mg/kg, chromium at 10 mg/kg, copper at 40 mg/kg, lead at 34 mg/kg, nickel at 13 mg/kg, thallium at 0.056 mg/kg, and zinc at 25 mg/kg.

Table 6.3
Metals Detected in Background Samples Collected at the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Metal	Sample Location Number, Interval (ft BLS), and Units	
	BS-004PZ (Soil) 8.5 - 10.0 (mg/kg)	BS-004PZ (Groundwater) (mg/L)
Arsenic	2	0.038
Beryllium	1.2	0.013
Cadmium	1.6	0.0006
Chromium	10	0.12
Copper	40	0.29
Lead	34	0.033
Nickel	13	0.16
Thallium	0.056	0.0057
Zinc	25	0.45

AOC – Area of Concern.
ft BLS – feet Below Land Surface.
BS – Burial Site AOC.
PZ – Piezometer.
mg/kg – milligrams per kilogram.
mg/L – milligrams per liter.

Table 6.4 summarizes the gross alpha and gross beta detections. Gross alpha and gross beta radiation were not detected in the soil sample collected.

Table 6.4
Gross Alpha and Gross Beta Radiation Detected in
Background Samples Collected at the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Analyte	Sample Location Number, Interval (ft BLS), and Units	
	BS-004PZ (Soil) 8.5 - 10.0 (pCi/g)	BS-004PZ (Groundwater) (pCi/L)
Gross alpha	0 ± 17	36 ± 42
Gross beta	0 ± 32	78 ± 25

AOC – Area of Concern.
BS – Burial Site AOC.
PZ – Piezometer.
ft BLS – feet Below Land Surface.
pCi/g – picoCuries per gram.
pCi/L – picoCuries per liter.

6.3.2.2 Groundwater

One investigative groundwater sample was collected from piezometer BS-004PZ on 21 July 1994 for laboratory analysis. A detailed description of the installation, development, and water level

measurement for piezometer BS-004PZ is given in Subsection 6.4.3.1. The analytical program for background groundwater sampling is indicated in Table 6.1.

No VOCs, SVOCs, TPH (diesel or gasoline range), or pesticides/PCBs were detected in the background groundwater sample.

The groundwater sample (unfiltered) collected from background piezometer BS-004PZ was also analyzed for priority pollutant metals. Those metals detected in this groundwater sample and their values are indicated in Table 6.3. Antimony, mercury, selenium, and silver were not detected in the groundwater sample, while arsenic was detected at 0.038 mg/L, beryllium at 0.013 mg/L, cadmium at 0.0006 mg/L, chromium at 0.12 mg/L, copper at 0.29 mg/L, lead at 0.033 mg/L, nickel at 0.16 mg/L, thallium at 0.0057 mg/L, and zinc at 0.45 mg/L.

The summary of gross alpha and gross beta detections in groundwater samples (unfiltered) is indicated in Table 6.4. Gross alpha and gross beta in groundwater were detected at 36 picoCuries per liter (pCi/L) and 78 pCi/L, respectively.

6.4 BURIAL SITE AOC

A detailed description of the AOC, including the locations of soil borings and piezometers, was given in Section 5.5.

6.4.1 Screening Activities

6.4.1.1 Geophysical Survey

A geophysical survey, using GPR and magnetometer investigation techniques as described in Subsections 5.2.1 and 5.5.1, was conducted on 10 June 1994. Complete geophysical survey results are provided in Appendix C.

6.4.1.1.1 Ground-Penetrating Radar Survey Results

The GPR data obtained on 11 vertical and 11 horizontal traverses of the Burial Site AOC revealed subsurface structures and disturbed soil areas. Figure 6.4 displays subsurface elements detected with the GPR, while Figures 6.5, 6.6, 6.7, and 6.8 present the characteristic GPR traces obtained for these elements. Two underground utilities were detected in the northern and eastern areas of the AOC using the GPR. Possible presence of these utilities was indicated (by

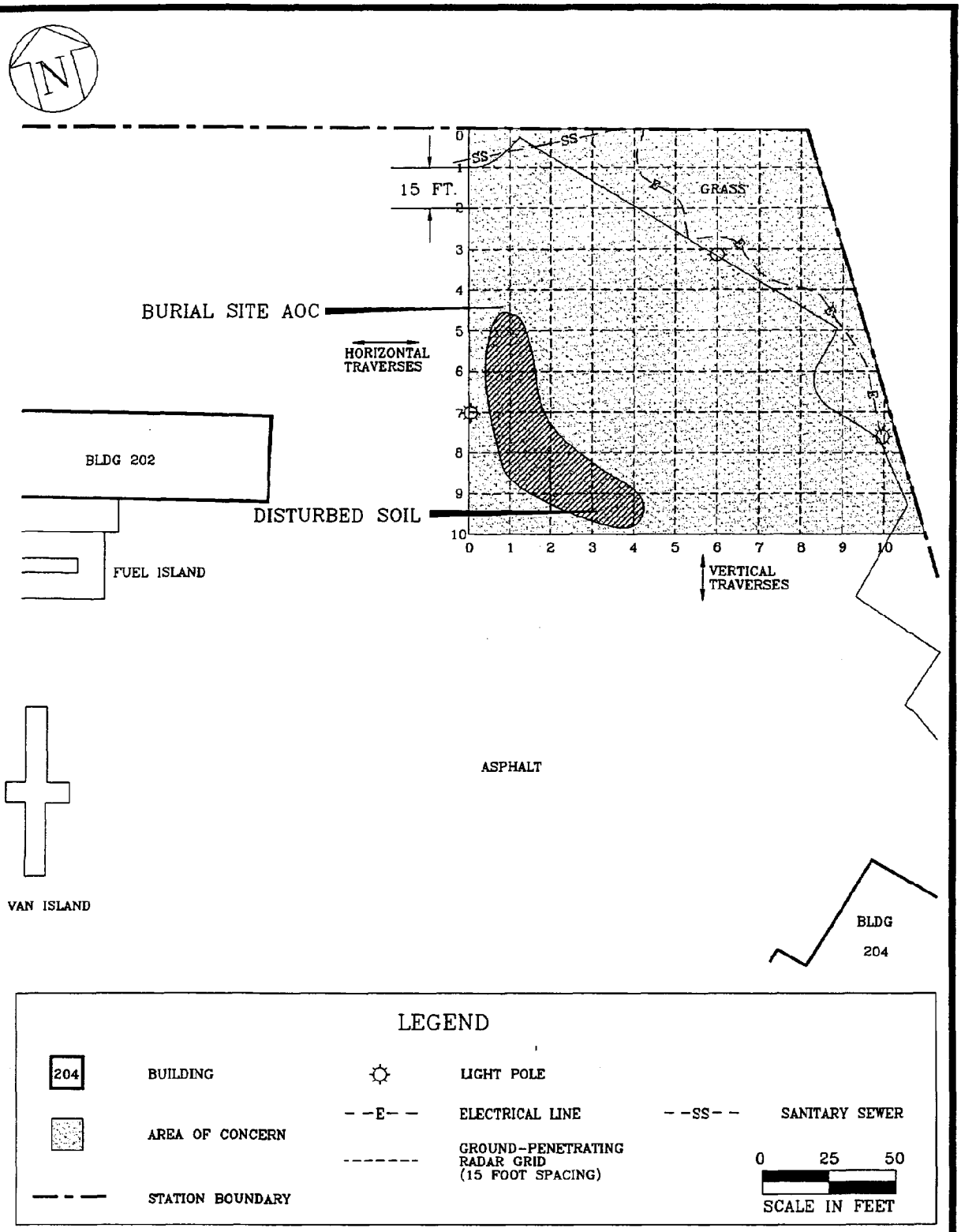

FIGURE 6.4

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BURIAL SITE AOC
GROUND-PENETRATING
RADAR SURVEY RESULTS
143rd CCSQ, Seattle ANGS
Seattle, Washington

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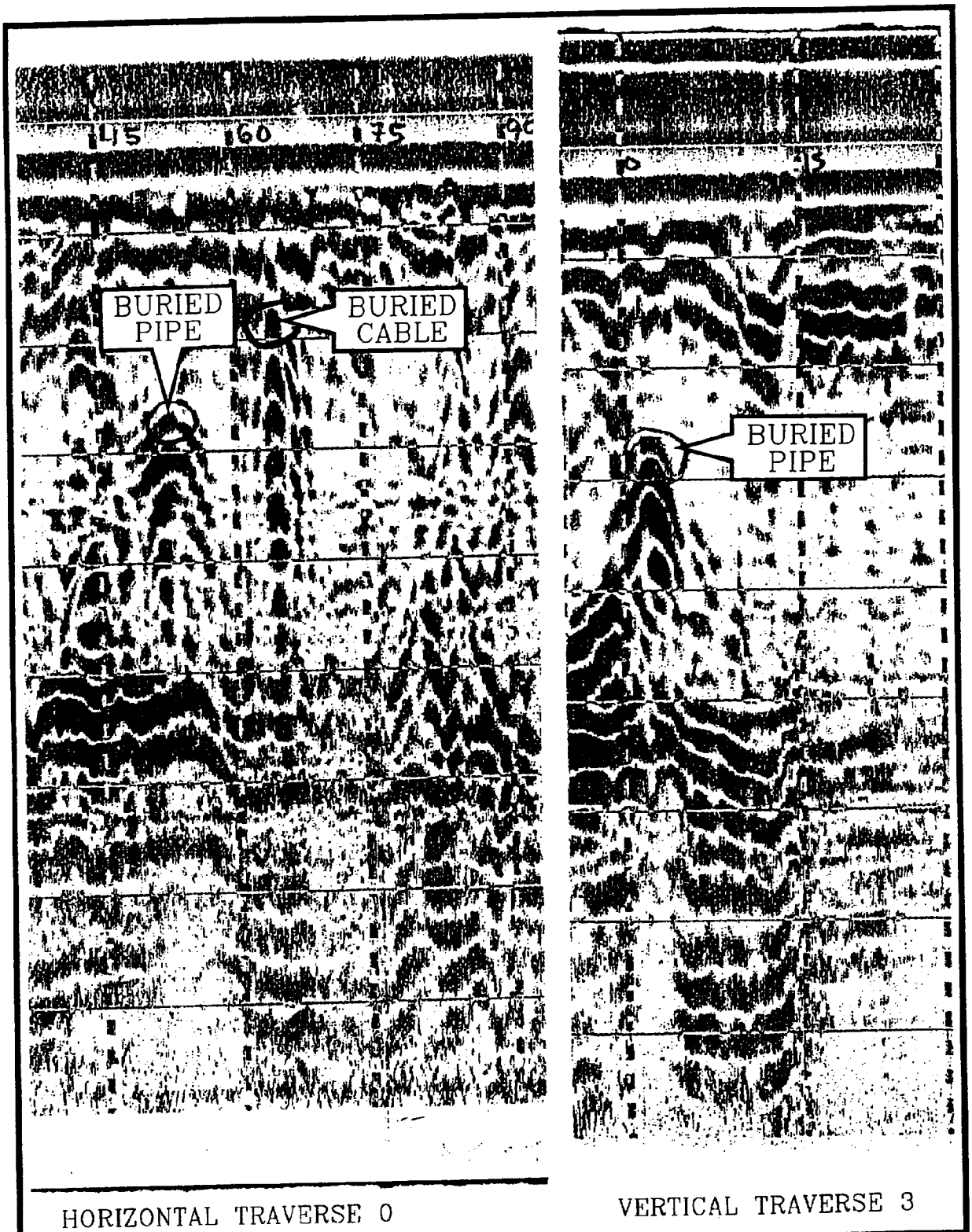

FIGURE 6.5

M:\SEATTLE\GPR

GPR TRACE FOR
HORIZONTAL TRAVERSE 0 AND
VERTICAL TRAVERSE 3
143rd CCSQ, Seattle ANGS
Seattle, Washington

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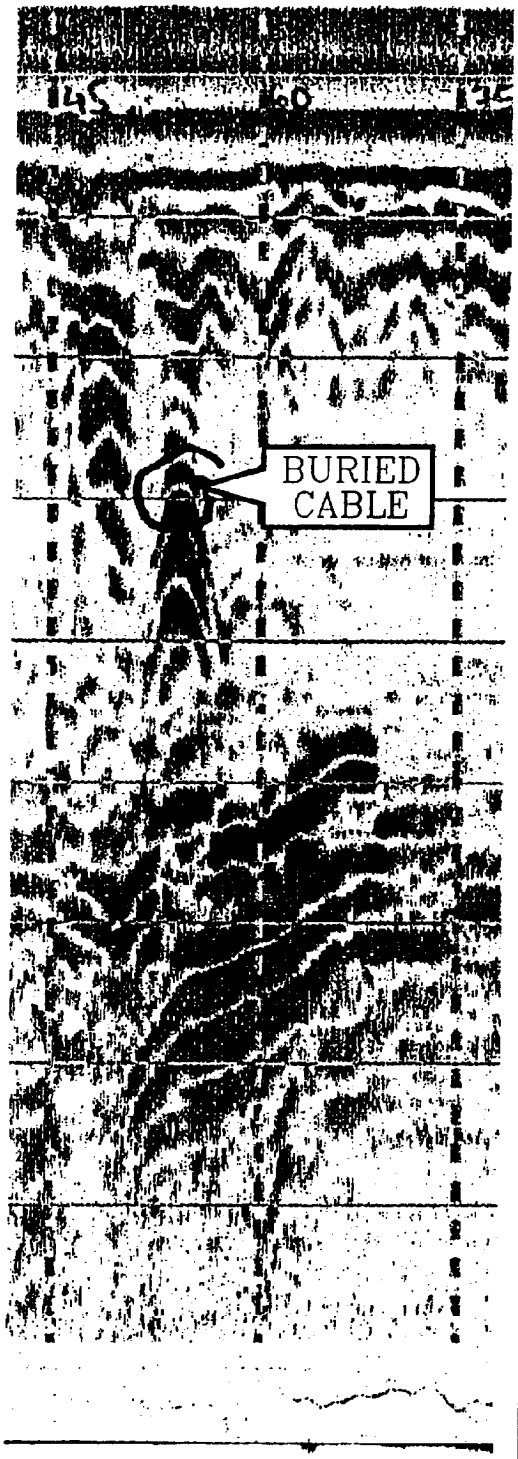
HORIZONTAL TRAVERSE 1



VERTICAL TRAVERSE 7

FIGURE 6.6

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GPR TRACE FOR
HORIZONTAL TRAVERSE 1 AND
VERTICAL TRAVERSE 7
143rd CCSQ, Seattle ANGS
Seattle, Washington

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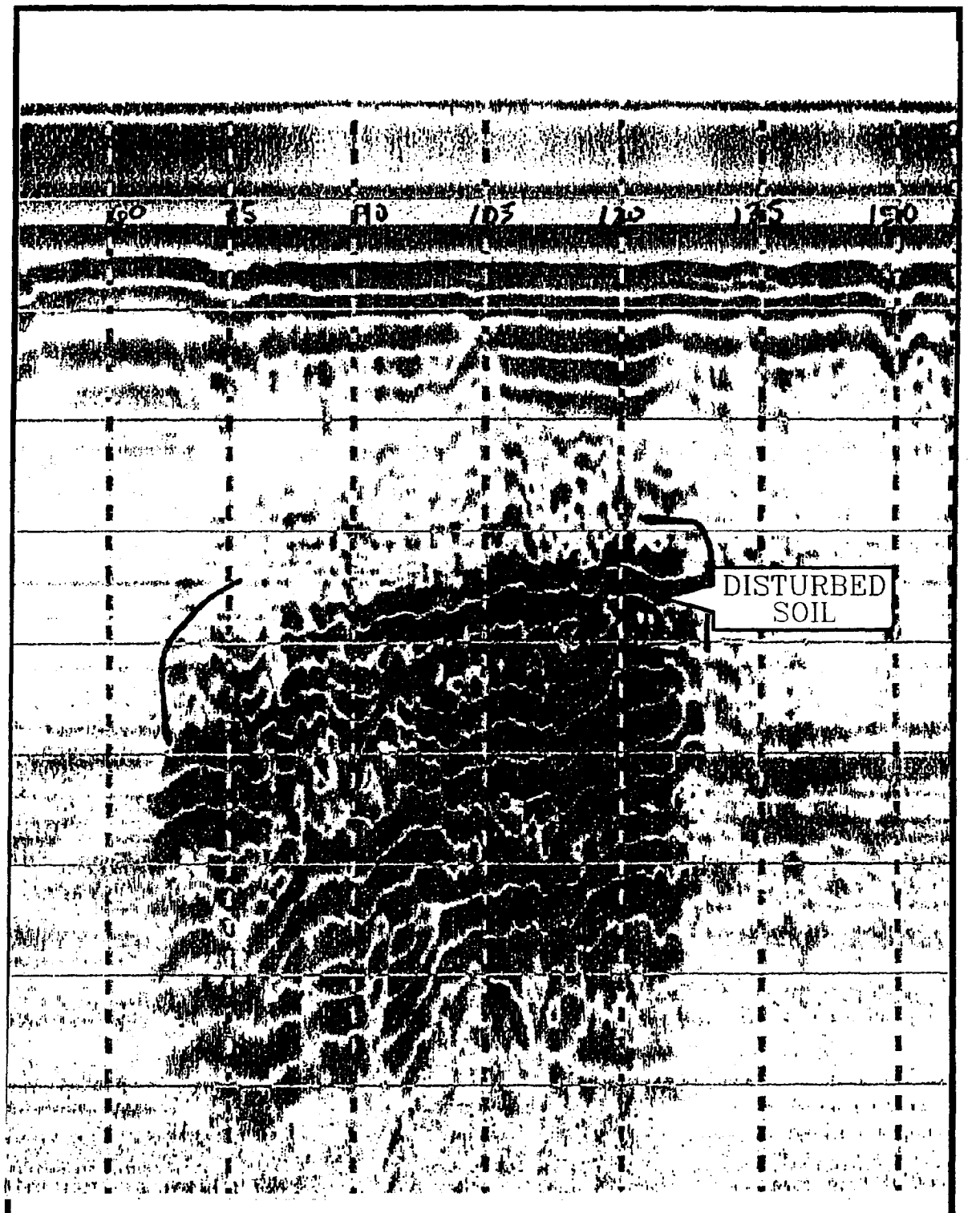

FIGURE 6.7 M:\SEATTLE\GPR	GPR TRACE FOR VERTICAL TRAVERSE 1 143rd CCSQ, Seattle ANGS Seattle, Washington	OPTECH OPERATIONAL TECHNOLOGIES CORPORATION MARCH 1995

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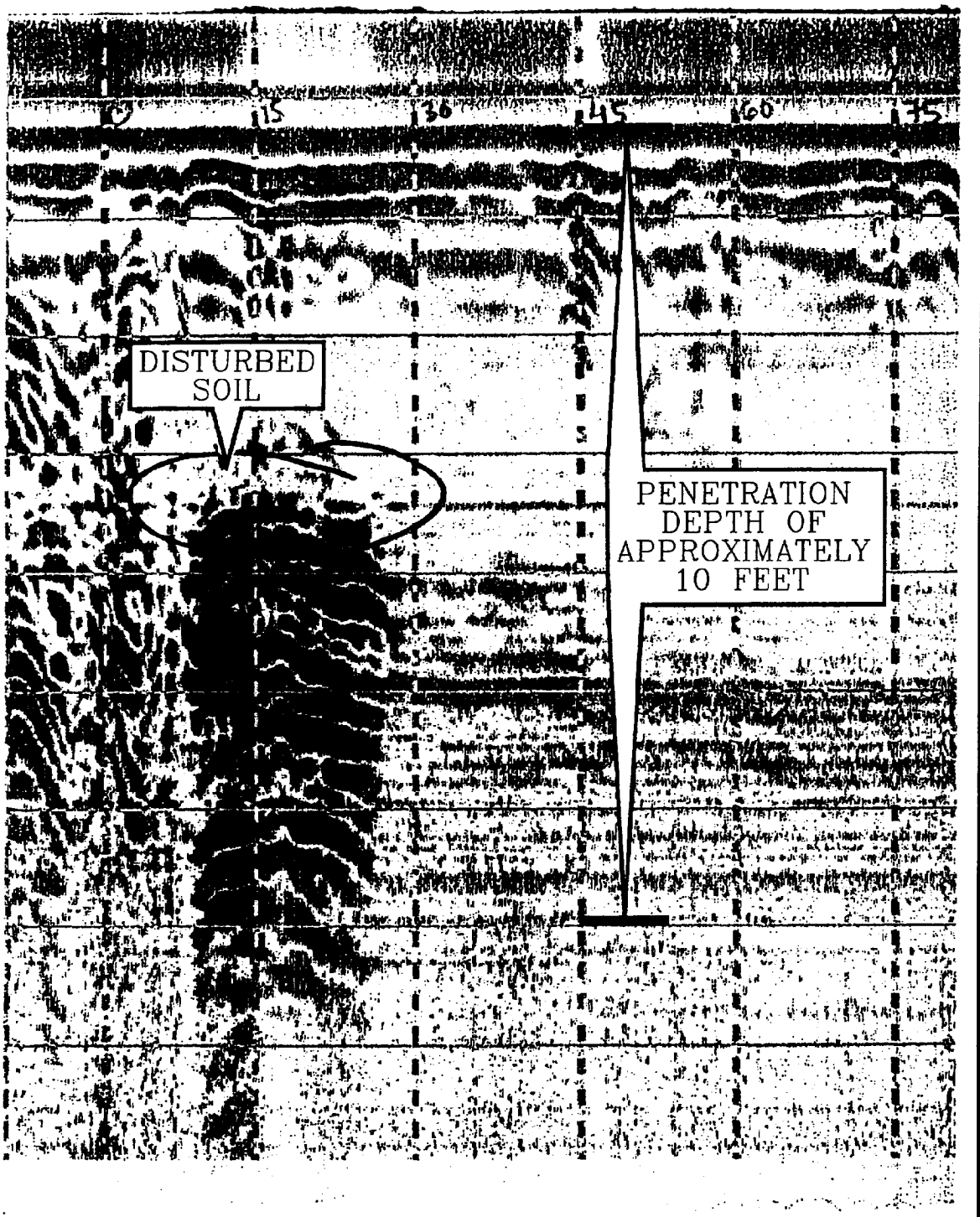

FIGURE 6.8

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GPR TRACE FOR
HORIZONTAL TRAVERSE 7
143rd CCSQ, Seattle ANGS
Seattle, Washington

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as-built drawings) before the survey was conducted. A large pipe was detected on several traverses, such as horizontal traverse 0 and vertical traverse 3 (see Figure 6.5), at approximately 4 feet BLS. The pipe location corresponded well with the location of a sanitary sewer pipe shown on as-built drawings. Similarly, a smaller pipe or cable was detected on numerous traverses (see Figures 6.5 and 6.6), at approximately 2 feet BLS in the northeastern and eastern areas of the AOC. These pipe or cable locations agreed well with the as-built drawing location of a buried electrical line leading to the two light poles in the north central and eastern portions of the AOC. Finally, a large area of a different soil horizon or disturbed soil, with an upper interface at approximately 4.5 to 6.0 feet BLS, was detected on numerous traverses in the southwestern area of the AOC. Figures 6.7 and 6.8 show typical traces over this area. The origin of this different soil material could be associated with the filling-in of the former Duwamish River, which ran in a northeast to southwest direction immediately south of the station, and was replaced by the straight path of the current Duwamish Waterway, located approximately 2,000 feet south of the station. The origin of this different soil material could also be associated with the burial or burning activities at this AOC, described in Subsection 4.2.1.1.

6.4.1.1.2 Magnetometer Survey Results

The magnetometer data obtained at the Burial Site AOC is shown as magnetic gradient contours and total magnetic field contours in Figures 6.9 and 6.10, respectively. The data show significant magnetic disturbances in specific areas of the AOC, all of which are attributable to surface interferences. Magnetic disturbances are significant along the northern and eastern boundaries of the AOC and are attributable to the fence line present there. There are also smaller isolated magnetic disturbances present in the north central and southwestern portions of the AOC, both of which are attributable to light poles at these two locations. There are no significant magnetic disturbances present which coincide with the area of disturbed soil detected with the GPR in the southwestern portion of the AOC, and therefore, this area is not suspected of being an area where significant metal masses are buried.

6.4.1.2 Soil Vapor Survey

A soil vapor survey was conducted on 5 July 1994, as described in Subsections 5.2.2 and 5.5.2. Toluene was detected at one of the 21 soil vapor sampling locations, sample location 5, at a concentration of 0.06 parts per million volume (ppmv). The detection limit for toluene is 0.01 ppmv. TVH was detected at all of the 21 soil vapor sampling locations, at concentrations ranging from 1 to 6 ppmv, with the highest concentration detected in sample location 2. The

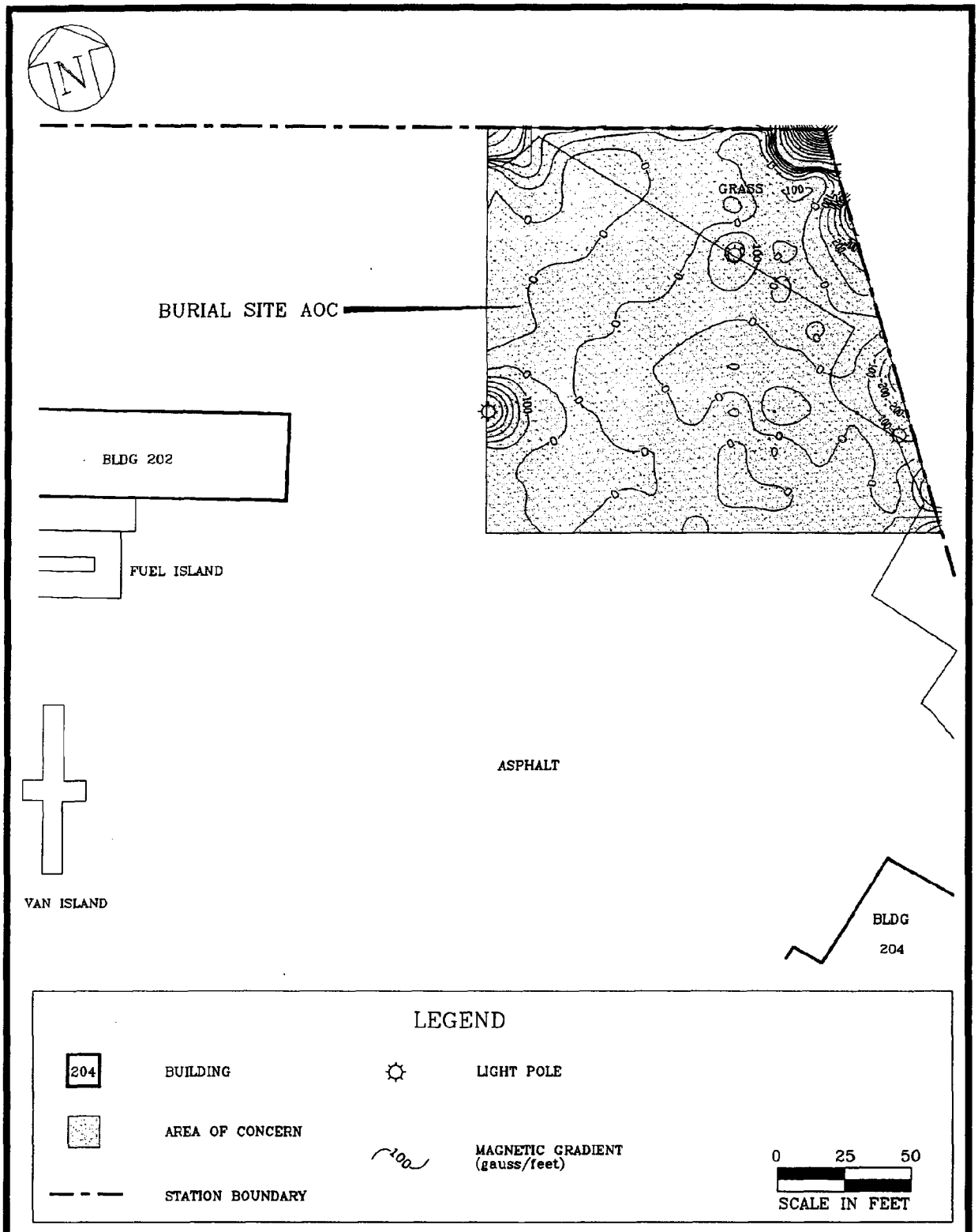

FIGURE 6.9

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BURIAL SITE AOC
MAGNETIC GRADIENT CONTOURS
143rd CCSQ, Seattle ANGS
Seattle, Washington

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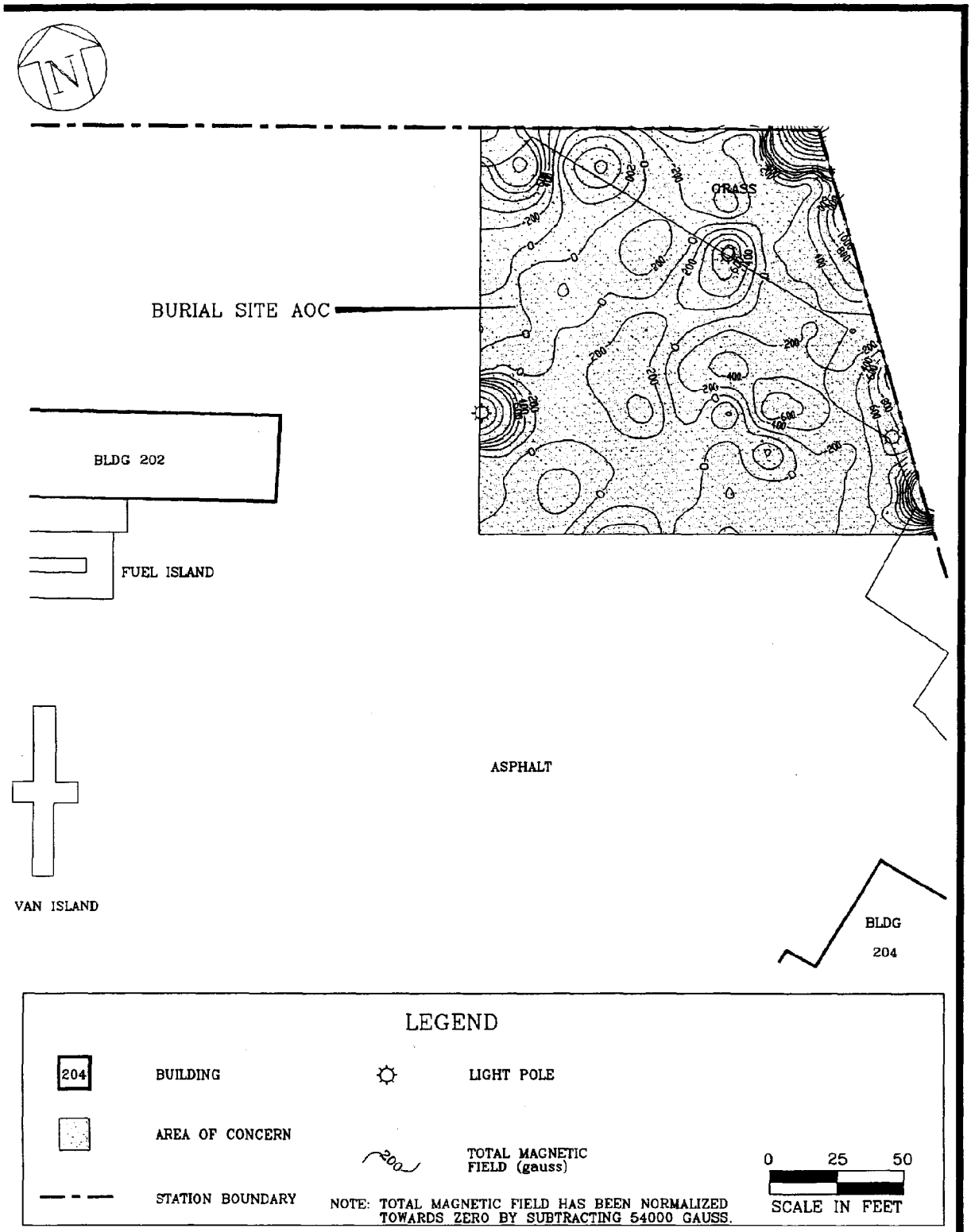

FIGURE 6.10

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BURIAL SITE AOC TOTAL MAGNETIC FIELD CONTOURS

143rd CCSQ, Seattle ANGS
Seattle, Washington

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detection limit for TVH is 1 ppmv. An isoconcentration map of TVH at the Burial Site AOC is shown in Figure 6.11. A complete listing of the soil vapor survey results is given in Appendix A.

6.4.1.3 Sample Field Screening

Twenty-four subsurface soil samples were field screened with a Photovac 10S50 Portable GC, as described in Subsection 5.2.3. The GC was calibrated to screen for BTEX. Table 6.5 summarizes the maximum concentrations of BTEX compounds detected by field screening of soil samples collected at the Burial Site AOC. Complete field GC data is presented in Appendix C.

Table 6.5
Maximum GC Concentrations Detected in Soil and Water Samples
143rd CCSQ, Seattle ANGS, Seattle, Washington

Compound	Maximum Concentrations Detected in Soil Samples (ppb)
Benzene	2
Toluene	42
Ethylbenzene	9
m,p-Xylenes	58
o-Xylenes	16

GC – Gas Chromatograph. ND – Not Detected.
ppb – parts per billion.

Benzene was detected in four of the 24 samples, with the highest concentration of 2 parts per billion (ppb) detected in sample BS-006PZ (3.5 - 5.0 feet BLS). Toluene was detected in 15 of the 24 samples, with the highest concentration of 42 ppb detected in sample BS-003BH (8.5 -10.0 feet BLS). Ethylbenzene was detected in six of the 24 samples, with the highest concentration of 9 ppb detected in sample BS-001BH (2.5 - 4.0 feet BLS). M,p-xylenes were detected in 14 of the 24 samples, with the highest concentration of 58 ppb detected in samples BS-004PZ (13.5 - 15.0 feet BLS) and BS-005PZ (8.5 - 10.0 feet BLS). O-xylene was detected in 11 of the 24 samples, with the highest concentration of 16 ppb detected in samples BS-004PZ (13.5 - 15.0 feet BLS) and BS-005PZ (8.5 - 10.0 and 13.5 - 15.0 feet BLS).

No BTEX compounds were detected in any of the three groundwater samples screened with the field GC.

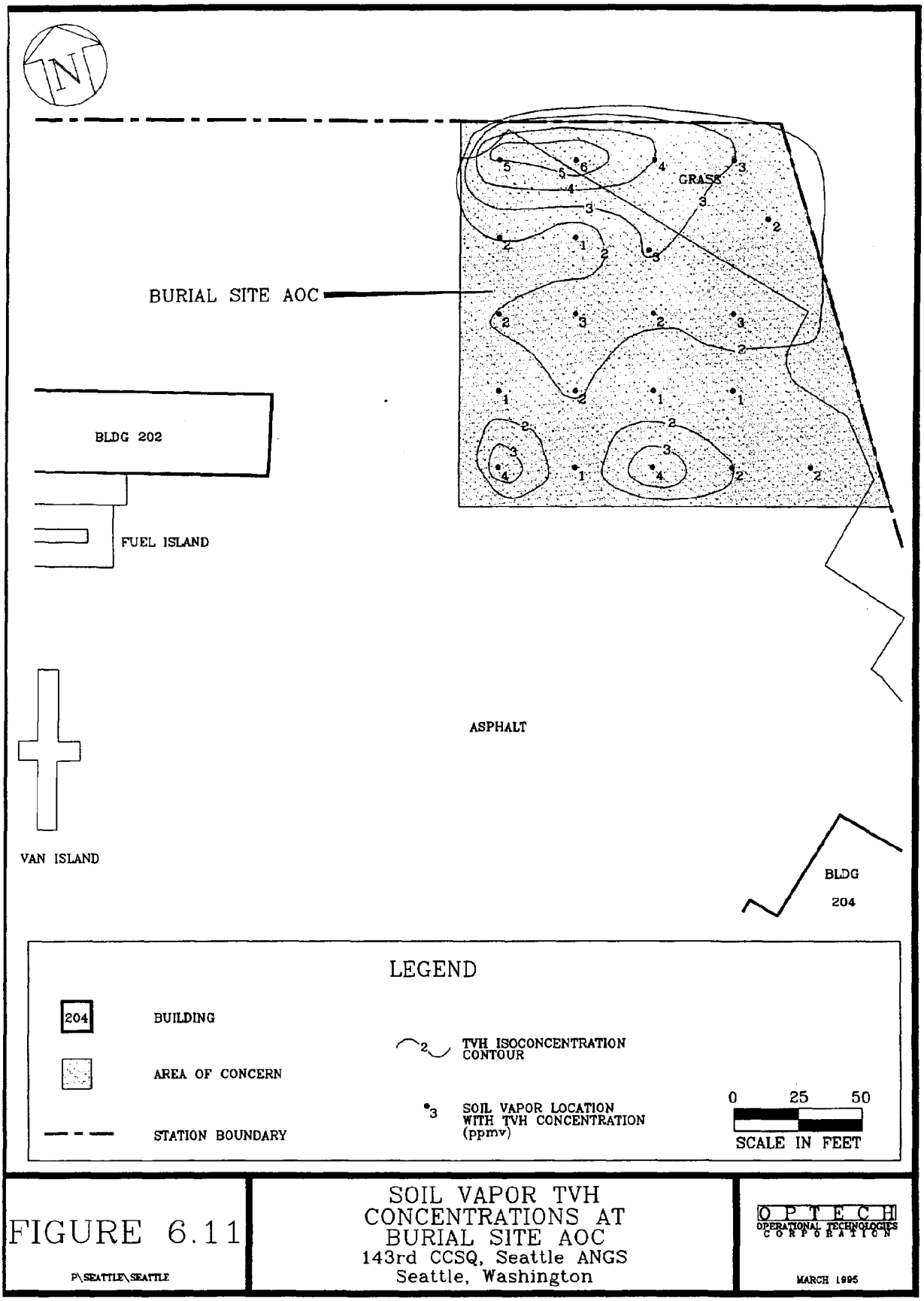

FIGURE 6.11

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SOIL VAPOR TVH CONCENTRATIONS AT BURIAL SITE AOC
143rd CCSQ, Seattle ANGS
Seattle, Washington

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6.4.2 Soil

Three soil borings were drilled at the Burial Site AOC using HSA methods, from which nine investigative samples were collected for laboratory analysis. The borings were drilled and samples collected on 14 July 1994. Sampling intervals submitted for laboratory analysis and the analytical program are presented in Table 6.6. A complete listing of laboratory results for all analyses at the AOC is given in Appendix E.

6.4.2.1 VOC Contamination

VOC contamination was not detected in any of the soil samples collected at the Burial Site AOC.

Table 6.6
Soil Sampling and Analytical Program for the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Sample Location Number	Sample Depth (ft BLS)	Soil Analyses and Methods					
		VOCs (SW8240)	SVOCs (SW8270)	Metals (SW6010†)	TPH (WTPH-D, WTPH-G)	Pest/PCBs (SW8080)	Gross Alpha & Gross Beta (SW9310)
BS-001BH	1.0 - 2.5	X	X	X	X	X	X
	5.5 - 7.0	X	X	X	X	X	X
	8.5 - 10.0	X	X	X	X	X	X
BS-002BH	1.0 - 2.5	X	X	X	X	X	X
	5.5 - 7.0	X	X	X	X	X	X
	8.5 - 10.0	X	X	X	X	X	X
BS-003BH	2.0 - 3.5	X	X	X	X*	X	X
	5.5 - 7.0	X	X	X	X*	X	X
	8.5 - 10.0	X	X	X	X	X	X

†All metals analyzed by SW6010 except: Arsenic – SW7060; Cadmium – SW7131; Chromium – SW7196; Lead – SW7421; Mercury – SW7470; Selenium – SW7740; and Thallium – SW7841.
AOC – Area of Concern.
ft BLS – feet Below Land Surface.
VOCs – Volatile Organic Compounds.
SVOCs – Semivolatile Organic Compounds.
TPH – Total Petroleum Hydrocarbons.
* – Also analyzed for TPH by EPA Method 418.1 (infrared method).
Pest/PCBs – Pesticides/Polychlorinated Biphenyls.
BS – Burial Site AOC.
BH – Borehole.
X – Indicates parameter was analyzed.
WTPH-G – Washington TPH-gasoline range (gas chromatography method).
WTPH-D – Washington TPH-diesel range (gas chromatography method).

6.4.2.2 SVOC Contamination

SVOC contamination in soil samples collected at the Burial Site AOC is shown in Table 6.7. The SVOC di-n-butyl phthalate was detected in eight of the soil samples collected at concentrations ranging from 744 μg/kg to 1,960 μg/kg, with the highest concentration detected

Table 6.7
Semivolatile Organic Compounds Detected in Soil Samples
Collected at the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Sample Location Number	Sample Depth (ft BLS)	Di-n-butyl phthalate* (µg/kg)
BS-001BH	1.0 - 2.5 5.5 - 7.0 8.5 - 10.0	1,750 1,680 1,590
BS-002BH	1.0 - 2.5 5.5 - 7.0 8.5 - 10.0	1,640 900 1,960
BS-003BH	5.5 - 7.0 8.5 - 10.0	744 1,750

AOC – Area of Concern.
ft BLS – feet Below Land Surface.
µg/kg – micrograms per kilogram.
BS – Burial Site AOC.
BH – Borehole.
PZ – Piezometer.
* – Common laboratory contaminant in SVOC analyses.

in sample BS-002BH (8.5 - 10.0 feet BLS). Di-n-butyl phthalate is a common laboratory contaminant in SVOC analyses (USEPA, 1993).

6.4.2.3 Metal Contamination

Metal contamination in soils collected at the Burial Site AOC is shown in Table 6.8. Eleven of the 13 priority pollutant metals analyzed were detected in these soil samples. Antimony and mercury were not reported above detection limits in any of the samples. Arsenic was detected at concentrations ranging from 0.033 mg/kg to 20 mg/kg, with the highest concentration detected in sample BS-003BH (5.5 - 7.0 feet BLS). Selenium was detected in two samples at concentrations of 0.053 mg/kg and 0.11 mg/kg, with the highest concentration detected in sample BS-003BH (8.5 - 10.0 feet BLS). Beryllium, chromium, lead, thallium, and zinc were detected at concentrations ranging from 0.29 mg/kg to 1.1 mg/kg, 7.9 mg/kg to 15 mg/kg, 9.7 mg/kg to 62 mg/kg, 0.03 mg/kg to 0.093 mg/kg, and 8.6 mg/kg to 40 mg/kg, respectively, with the highest concentration detected in sample BS-003BH (5.5 - 7.0 feet BLS). Cadmium, copper, nickel, and silver were detected at concentrations ranging from 0.66 mg/kg to 1.6 mg/kg, 7.5 mg/kg to 130 mg/kg, 5.6 mg/kg to 14 mg/kg, and 0.042 mg/kg to 0.18 mg/kg, respectively, with the highest concentration detected in sample BS-001BH (1.0 - 2.5 feet BLS). The highest concentration of a majority of the metals detected came from samples from boring BS-003BH, which is located directly adjacent to the disturbed soil area detected by the GPR (see Subsection 6.4.1.1.1).

Table 6.8
Metals Detected in Soil Samples Collected at the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Metal	Sample Location Number, Interval (ft BLS), and Units								
	BS-001BH 1.0 - 2.5 (mg/kg)	BS-001BH 5.5 - 7.0 (mg/kg)	BS-001BH 8.5 - 10.0 (mg/kg)	BS-002BH 1.0 - 2.5 (mg/kg)	BS-002BH 5.5 - 7.0 (mg/kg)	BS-002BH 8.5 - 10.0 (mg/kg)	BS-003BH 2.0 - 3.5 (mg/kg)	BS-003BH 5.5 - 7.0 (mg/kg)	BS-003BH 8.5 - 10.0 (mg/kg)
Arsenic	0.33	1.6	0.033	2.7	1.1	0.63	4.1	20	3.7
Beryllium	1	0.82	0.29	0.87	0.49	0.34	1	1.1	0.58
Cadmium	1.6	1.1	0.66	1.3	0.92	0.75	1.3	1.5	1
Chromium	11	11	7.9	10	14	9.3	11	15	12
Copper	130	16	9.3	23	23	7.5	20	33	14
Lead	28	16	9.7	28	15	10	27	62	29
Nickel	14	5.8	5.6	9.3	6.2	7.2	8.6	14	8.3
Selenium	0.053	0.04U	0.04U	0.04U	0.04U	0.04U	0.04U	0.04U	0.11
Silver	0.18	0.04U	0.04U	0.04U	0.04U	0.04U	0.04U	0.042	0.04U
Thallium	0.038	0.03	0.02U	0.024	0.054	0.02U	0.053	0.093	0.02U
Zinc	19	8.6	14	31	16	20	19	40	20

AOC – Area of Concern.
mg/kg – milligrams per kilogram.
ft BLS – feet Below Land Surface.
BS – Burial Site AOC.
BH – Borehole.
U – Compound analyzed for but not detected. Number indicates the detection limit.

6.4.2.4 TPH Contamination

Neither diesel range (C_{12} to C_{24}) nor gasoline range (C_6 to C_{12}) TPH contamination was detected in any of the nine soil samples collected at the Burial Site AOC. The analysis of two samples by the WTPH gas chromatographic methods did indicate possible contamination with heavier hydrocarbons, and therefore these samples were analyzed by EPA Method 418.1 (an infrared spectrophotometric method), as directed in the Washington DOE TPH Analytical Methods. TPH was detected using EPA Method 418.1 at 780 mg/kg in sample BS-003BH (2.0 - 3.5 feet BLS) and at 160 mg/kg in sample BS-003BH (5.5 - 7.0 feet BLS).

6.4.2.5 Pesticide/PCB Contamination

Pesticides/PCBs were not detected in any of the nine soil samples collected at the Burial Site AOC.

6.4.2.6 Gross Alpha and Gross Beta Contamination

Gross alpha and gross beta contamination in soil at the Burial Site AOC is shown in Table 6.9. The gross alpha concentrations ranged from 0 picoCuries per gram (pCi/g) to 4 pCi/g, with the highest concentration detected in sample BS-001BH (1.0 - 2.5 feet BLS). The gross beta concentrations range from 0 to 4 pCi/g, with the highest concentration detected in sample BS-001BH (5.5 - 7.0 feet BLS).

6.4.3 Groundwater

6.4.3.1 Groundwater Conditions

Three piezometers were drilled at the Burial Site AOC to obtain water level data for hydrogeological characterization of the aquifer, and to obtain groundwater samples for laboratory analysis. Piezometers BS-004PZ, BS-005PZ, and BS-006PZ were drilled and installed on 14 July 1994. All three piezometers were drilled to a total depth of 20.5 feet BLS and the screens were set at 9 to 19 feet BLS. Piezometer BS-004PZ was used for background sampling of soil and groundwater, as described in Section 6.3. Complete piezometer construction diagrams are presented in Appendix D.

Table 6.9
Gross Alpha and Gross Beta Radiation Detected in Soil Samples Collected at the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Sample Location Number	Sample Depth (ft BLS)	Analyte	
		Gross Alpha (pCi/g)	Gross Beta (pCi/g)
BS-001BH	1.0 - 2.5	4 ± 27	2 ± 35
	5.5 - 7.0	0 ± 18	4 ± 36
	8.5 - 10.0	0 ± 20	0 ± 24
BS-002BH	1.0 - 2.5	2 ± 25	3 ± 37
	5.5 - 7.0	2 ± 25	0 ± 36
	8.5 - 10.0	2 ± 25	0 ± 34
BS-003BH	2.0 - 3.5	2 ± 20	2 ± 30
	5.5 - 7.0	0 ± 21	0 ± 34
	8.5 - 10.0	0 ± 21	0 ± 34

AOC – Area of Concern.
ft BLS – feet Below Land Surface.
BS – Burial Site AOC.
BH – Borehole.
pCi/g – picoCuries per gram.
NA – Not Analyzed.

Piezometers BS-004PZ, BS-005PZ, and BS-006PZ were developed using a bailer on 19, 18, and 19 July 1994, respectively. Water level measurements were taken from each piezometer on 21 July 1994 (see Table 6.10). Figure 6.12 shows the potentiometric surface determined using these measurements. Groundwater flow direction is toward the south-southeast, with an average hydraulic gradient of 0.0033 feet per foot. Temperature, pH, and specific conductance were measured for each groundwater sample as listed in Table 6.10.

Table 6.10
Temperature, pH, Specific Conductance, and Water Level Data for Burial Site AOC Piezometers
143rd CCSQ, Seattle ANGS, Seattle, Washington

Piezometer	Temperature (° F)	pH	Specific Conductance (mmhos)	Depth to Water (feet BLS)	Water Table Elevation (MSL)
BS-004PZ	60.5	6.19	231	9.45	-0.46
BS-005PZ	60.5	6.08	325	9.81	-1.09
BS-006PZ	64.7	6.74	407	9.78	-0.87

MSL – Mean Sea Level.
BS – Burial Site AOC.
PZ – Piezometer.
° F – degrees Fahrenheit.
ft BLS – feet Below Land Surface.
mmhos – millimhos.

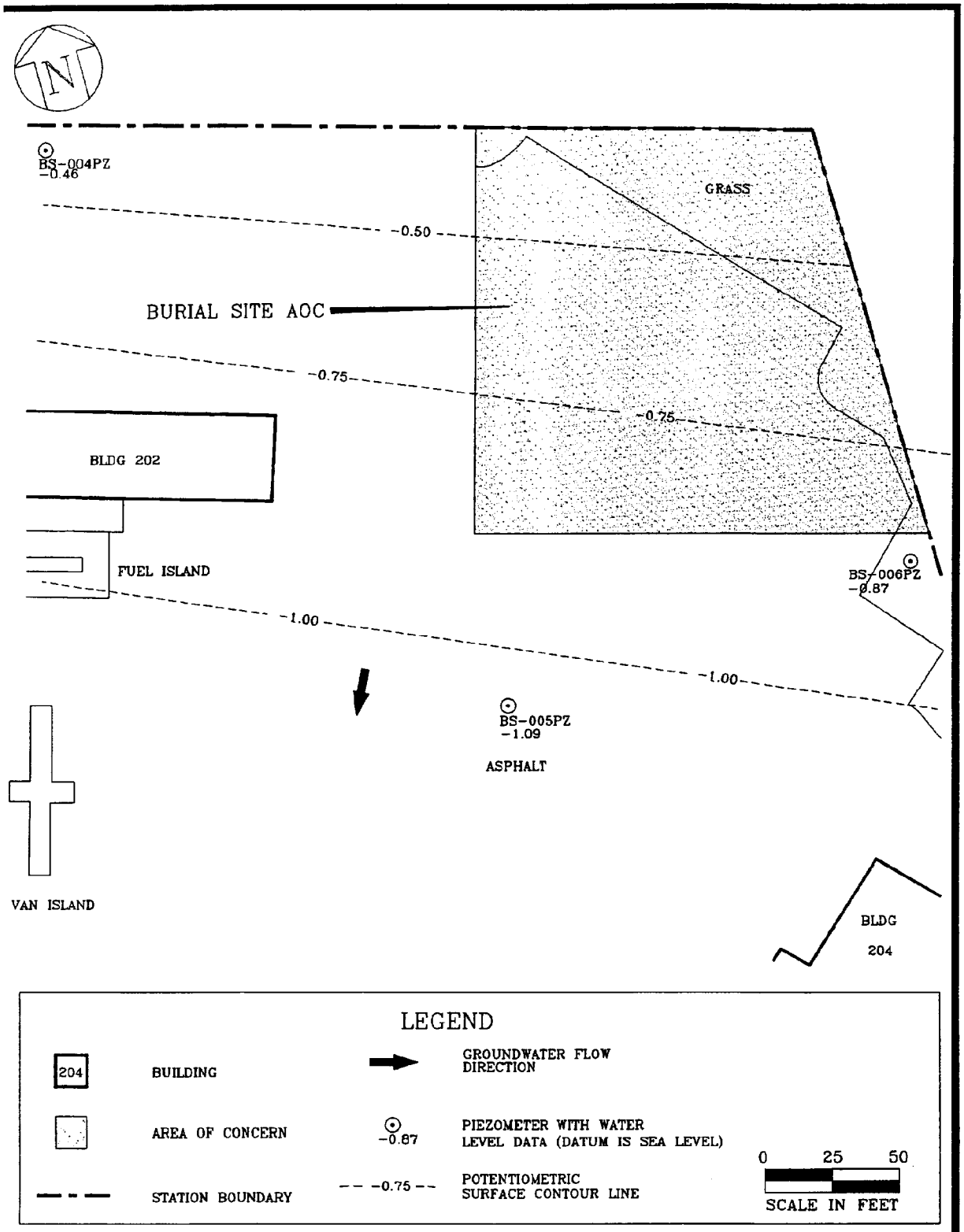

FIGURE 6.12

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POTENTIOMETRIC SURFACE MAP
FOR 21 JULY 1994
143rd CCSQ, Seattle ANGS
Seattle, Washington

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6.4.3.2 Groundwater Contamination

Two groundwater samples were collected at the Burial Site AOC for laboratory analysis. These groundwater samples were collected from piezometers BS-005PZ and BS-006PZ on 20 and 21 July 1994, respectively. The analytical program for groundwater samples at the AOC is presented in Table 6.11. A complete listing of laboratory results for all analyses at the AOC is given in Appendix E.

Table 6.11
Groundwater Sampling and Analytical Program for the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Sample Location Number	Groundwater Analyses and Methods					
	VOCs (SW8240)	SVOCs (SW8270)	Metals (SW6010†)	TPH (WTPH-D)	Pest/PCBs (SW8080)	Gross Alpha & Gross Beta (SW9310)
BS-005PZ	X	X	X	X	X	X
BS-006PZ	X	X	X	X	X	X

†All metals analyzed by SW6010 except: Arsenic – SW7060; Cadmium – SW7131; Chromium – SW7196; Lead – SW7421; Mercury – SW7470; Selenium – SW7740; and Thallium – SW7841.
AOC – Area of Concern.
VOCs – Volatile Organic Compounds.
SVOCs – Semivolatile Organic Compounds.
WTPH-D – Washington TPH-diesel range (gas chromatography method).
TPH – Total Petroleum Hydrocarbons.
Pest/PCBs – Pesticides/Polychlorinated Biphenyls.
BS – Burial Site AOC.
PZ – Piezometer.
X – Indicates parameter was analyzed.

6.4.3.2.1 VOC Contamination

VOCs were not detected in either of the two groundwater samples collected at the Burial Site AOC.

6.4.3.2.2 SVOC Contamination

SVOCs were not detected in either of the two groundwater samples collected at the Burial Site AOC.

6.4.3.2.3 Metal Contamination

Metal contamination in groundwater collected at the Burial Site AOC is shown in Table 6.12. Only seven of the 13 priority pollutant metals analyzed were detected in these groundwater samples (unfiltered). Antimony, cadmium, mercury, silver, thallium, and zinc were not reported

Table 6.12
Metals Detected in Groundwater Samples Collected at the Burial Site AOC
143rd CCSQ, Seattle ANGS, Seattle, Washington

Metal	Sample Location Number and Units	
	BS-005PZ (mg/L)	BS-006PZ (mg/L)
Arsenic	0.028	0.027
Beryllium	0.54	0.82
Chromium	0.0052	0.097
Copper	0.054	0.078
Lead	0.022	0.026
Nickel	0.031	0.06
Selenium	0.002	0.0031

AOC – Area of Concern.
ft BLS – feet Below Land Surface.
BS – Burial Site AOC.
PZ – Piezometer.
mg/L – milligrams per liter.

above detection limits in either of the samples. Arsenic was detected at concentrations ranging from 0.027 mg/L to 0.028 mg/L, with the highest concentration detected in sample BS-005PZ. Beryllium, chromium, copper, lead, nickel, and selenium were detected at concentrations ranging from 0.54 mg/L to 0.82 mg/L, 0.0052 mg/L to 0.097 mg/L, 0.054 mg/L to 0.078 mg/L, 0.022 mg/L to 0.026 mg/L, 0.031 mg/L to 0.06 mg/L, and 0.002 mg/L to 0.0031 mg/L, respectively, with the highest concentration detected in sample BS-006PZ.

6.4.3.2.4 TPH Contamination

TPH (diesel range) contamination was not detected in either of the two groundwater samples collected at the Burial Site AOC.

6.4.3.2.5 Pesticide/PCB Contamination

Pesticides/PCBs were not detected in either of the two groundwater samples collected at the Burial Site AOC.

6.4.3.2.6 Gross Alpha and Gross Beta Contamination

Gross alpha and gross beta contamination in groundwater samples (unfiltered) at the Burial Site AOC is shown in Table 6.13. The gross alpha concentrations ranged from 15 pCi/L to 59 pCi/L, with the highest concentration detected in sample BS-006PZ. The gross beta

Table 6.13
Gross Alpha and Gross Beta Radiation Detected in Groundwater Samples Collected at the Burial Site AOC 143rd CCSQ, Seattle ANGS, Seattle, Washington

Analyte	Sample Location Number and Units	
	BS-005PZ (pCi/L)	BS-006PZ (pCi/L)
Gross alpha	15 ± 39	59 ± 59
Gross beta	77 ± 24	58 ± 30

AOC – Area of Concern.
BS – Burial Site AOC.
PZ – Piezometer.
pCi/L – picoCuries per liter.

concentrations ranged from 58 pCi/L to 77 pCi/L, with the highest concentration detected in sample BS-005PZ.

Section 7

SECTION 7.0 CONCLUSIONS

7.1 SUMMARY

ANGRC/CEVR authorized OpTech to prepare a PA/SI Work Plan and conduct PA and SI activities at the 143rd CCSQ, Seattle ANGS, Seattle, Washington. The PA was initiated by ANGRC personnel in December 1991, during which one AOC was identified for further investigation based on past waste handling and disposal practices. Field SI activities were conducted as outlined in the PA/SI Work Plan submitted to ANGRC in April 1994. The SI at the 143rd CCSQ commenced on 5 July 1994 and was completed on 27 July 1994.

The field work at the 143rd CCSQ was accomplished by completing the following tasks:

- Conducting a soil vapor survey to determine optimum soil boring locations;
- Performing a geophysical survey of the AOC to locate large buried items or backfilled areas;
- Field screening with the GC and PID to aid in the selection of soil samples to be submitted to the laboratory;
- Drilling three soil borings, to determine whether subsurface soil contamination exists at the AOC;
- Drilling three piezometers to obtain water level data and collect groundwater samples;
- Submitting a total of 13 samples for analysis of VOCs, SVOCs, priority pollutant metals, TPH, pesticides/PCBs, and gross alpha and gross beta radiation; and
- Surveying the location and elevation of all soil borings and piezometers.

The evaluation of analytical results obtained for the 13 samples entails comparison to applicable, relevant and appropriate requirements (ARARs). The Washington DOE has established cleanup levels through their Model Toxics Control Act (MTCA) Cleanup Regulation (Washington DOE, 1993a) and MTCA Summary of Cleanup Level Methods (Washington DOE, 1993b). According to these documents, cleanup method either A or B is applicable for this site. As shown in

Section 6.0, there was not a large number of hazardous substances identified in this SI. Method A is applicable when there are relatively few hazardous substances present at a site (Washington Administrative Code 173-340-740(4)). Therefore, MTCA Method A standards for soil and groundwater are used for comparison to concentrations of substances detected (see Table 7.1). Appropriate Method B values are also used for comparison when Method A values are unavailable.

Table 7.1
Summary of Analytes Exceeding Action Levels
143rd CCSQ, Seattle ANGS, Seattle, Washington

Sample Matrix	Sample Location	Analyte	Concentration	Standard Exceeded	Standard Concentration
Soil	All Samples	Beryllium	0.29 - 1.1 mg/kg*	MTCA B	0.233 mg/kg
	BS-003BH	TPH	160 - 780 mg/kg	MTCA A	200 mg/kg
Groundwater	2 Samples	Arsenic	0.027 - 0.028 mg/L*	MTCA A	0.005 mg/L
	2 Samples	Beryllium	0.54 - 0.82 mg/L	MTCA B	0.00002 mg/L
	BS-006PZ	Chromium	0.097 mg/L*	MTCA A	0.05 mg/L
	2 Samples	Lead	0.022 - 0.026 mg/L*	MTCA A	0.005 mg/L
	BS-006PZ	Gross Alpha	59 pCi/L	MTCA A	15.0 pCi/L
	2 Samples	Gross Beta	58 - 77 pCi/L*	SDWA MCL	50 pCi/L

* – Concentration detected did not exceed site-specific background concentration.
mg/kg – milligrams per kilograms.
mg/L – milligrams per liter.
BS – Burial Site AOC.
BH – Borehole.
PZ – Piezometer.
TPH – Total Petroleum Hydrocarbons.
pCi/L – picoCuries per liter.
MTCA A – Model Toxics Control Act Method A.
MTCA B – Model Toxics Control Act Method B.
SDWA MCL - Safe Drinking Water Act Maximum Contaminant Level.

For metals contamination, data from a United States Geological Survey (USGS) Report (Shacklette and Boerngen, 1984) and United States Department of Agriculture (USDA) Soil Conservation Service Report (Holmgren, Meyer, Chaney, and Daniels, 1993), which describe naturally-occurring metals concentrations in soils across the United States, are used for comparison purposes. Metals are also compared to site-specific background soil and groundwater levels determined during this investigation (see Subsection 6.3.2).

7.2 BURIAL SITE AOC CONCLUSIONS

7.2.1 Soil Contamination

VOCs were not detected in any of the nine soil samples collected.

One SVOC compound, di-n-butyl phthalate, was detected in soil samples collected at this AOC. Di-n-butyl phthalate was detected in eight of the nine soil samples. The maximum detected concentration was 1,960 μg/kg. This is well below the MTCA Method B cleanup level of 8,000 mg/kg. Di-n-butyl phthalate is a common laboratory contaminant in SVOC analyses (USEPA, 1993).

The average and maximum concentrations of metals detected in soils collected at this AOC are presented in Table 7.2. These values are compared with site-specific background levels, reported naturally-occurring metals concentrations, and Washington DOE action levels. As presented in Table 7.2, the average and maximum concentrations for each metal detected are below or approximately equal to the range of naturally-occurring concentrations, except for cadmium. The average concentration of each metal detected is also less than or approximately equal to the site-specific background concentration, except for arsenic, selenium, and silver; the latter two metals were not detected in the background soil sample. In comparison to the Washington DOE action levels, only beryllium exceeds these limits. The highest concentration of a majority of the metals detected came from samples from boring BS-003BH, adjacent to an area of disturbed soil detected in the GPR survey (see Subsection 6.4.1.1.1).

TPH was detected by EPA Method 418.1 in two samples from one boring, namely BS-003BH. In the first sample (BS-003BH, 2.0 - 3.5 feet BLS), TPH was detected at 780 mg/kg, while in the second sample (BS-003BH, 5.5 - 7.0 feet BLS), TPH was detected at 160 mg/kg. The TPH concentration in the first sample exceeds the Washington DOE action level for TPH (other than gasoline or diesel ranges) of 200 mg/kg.

Pesticides/PCBs were not detected in any of the nine soil samples collected.

Gross alpha and gross beta radiation were detected in soil samples collected at this AOC. Gross alpha and gross beta were detected at concentrations ranging from 0 pCi/g to 4 pCi/g and 0 pCi/g to 4 pCi/g, respectively. There are no Federal or State action levels for gross alpha and gross beta in soils. The background levels detected in soil at this AOC are 0 pCi/g for both gross alpha and gross beta.

Table 7.2
Comparison of Metals Detected in Soil Samples
143rd CCSQ, Seattle ANGS, Seattle, Washington

Metal	Investigative Samples with Analyte Detected (9 Total Samples)	Average (mg/kg)	Maximum (mg/kg)	Site-Specific Background	Range of Naturally-Occurring Concentrations in Soils in Western Washington+ (mg/kg)	WDOE Action Level	
						Method A† (mg/kg)	Method B‡ (mg/kg)
Arsenic	9	3.8	20	2	6.5 - 16	20	1.43
Beryllium	9	0.72	1.1	1.2	1.0	–	0.233
Cadmium	9	1.13	1.6	1.6	0.08 - 0.16*	2.0	40
Chromium	9	11	15	10	300 - 700	100	400
Copper	9	31	130	40	20 - 50	–	2,960
Lead	9	25	62	34	100 - 200	250	–
Nickel	9	8.8	14	13	100 - 200	–	1,600
Selenium	2	0.082	0.11	0.04U	0.3 - 0.7	–	400
Silver	2	0.11	0.18	0.04U	NA	–	240
Thallium	6	0.049	0.093	0.056	NA	–	5.6
Zinc	9	21	40	25	28 - 74	–	24,000

†Method A: The Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC, 1993.
‡Method B: Model Toxics Control Act Summary of Cleanup Level Methods, Washington DOE, 1993.
U – Compound analyzed for but not detected. Number indicates detection limit.
+Source: Shacklette and Boerngen, 1984.
* – Source: Holmgren, Meyer, Chaney, and Daniels, 1993.
mg/kg – milligrams per kilograms.
NA – No data available.
WDOE – Washington Department of Ecology.

7.2.2 Groundwater Contamination

VOCs and SVOCs were not detected in either of the two groundwater samples collected.

The average and maximum concentrations of metals detected in groundwater collected at this AOC are presented in Table 7.3. These values are compared with site-specific background levels and Washington DOE action levels. As presented in Table 7.3, the average and maximum concentrations for each metal detected in groundwater samples are below the site-specific background levels except for beryllium and selenium. In comparison to the Washington DOE action levels, four metals in groundwater samples, arsenic, beryllium, chromium, and lead exceed these limits.

TPH and pesticides/PCBs were not detected in either of the two groundwater samples collected.

Gross alpha and gross beta radiation were detected in groundwater samples collected at this AOC. Gross alpha and gross beta were detected at concentrations ranging from 15 pCi/L to 59 pCi/L and 58 pCi/L to 77 pCi/L, respectively. The State action level for gross alpha radiation in groundwater (unfiltered water sample) is 15.0 pCi/L. The Federal Maximum Contaminant Level (MCL) for gross beta radiation in drinking water (Safe Drinking Water Act) is 50 pCi/L (unfiltered water sample). The background levels detected in groundwater at this AOC are 36 pCi/L for gross alpha and 78 pCi/L for gross beta.

Table 7.3
Comparison of Metals Detected in Groundwater
143rd CCSQ, Seattle ANGS, Seattle, Washington

Metal	Investigative Samples with Analyte Detected (2 Total Samples)	Average (mg/L)	Maximum (mg/L)	Background Groundwater (mg/L)	WDOE Action Level	
					Method A† (mg/L)	Method B‡ (mg/L)
Arsenic	2	0.028	0.028	0.038	0.005	0.00005
Beryllium	2	0.68	0.82	0.013	–	0.00002
Chromium	2	0.051	0.097	0.12	0.05	0.080
Copper	2	0.066	0.078	0.29	–	0.592
Lead	2	0.024	0.026	0.033	0.005	–
Nickel	2	0.0455	0.06	0.16	–	0.320
Selenium	2	0.0026	0.0031	0.002U	–	0.080

†Method A: The Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC, 1993.
‡Method B: Model Toxics Control Act Summary of Cleanup Level Methods, Washington DOE, 1993.
mg/L – milligrams per liter.

WDOE – Washington Department of Ecology.
U – Compound analyzed for but not detected. Number indicates the detection limit.

Section 8

SECTION 8.0 RECOMMENDATIONS

8.1 BURIAL SITE AOC RECOMMENDATIONS

Based on the results of the PA/SI conducted, further investigation is recommended to determine the source and areal extent of TPH contamination detected in borehole BS-003BH, and the gross alpha and gross beta radiation detected in the groundwater samples collected at the Burial Site AOC.

State action levels were also variously exceeded for metals such as arsenic, beryllium, chromium, and lead, yet the average of each of the detected metals concentrations in respective media does not exceed site-specific background concentrations, except for beryllium in the groundwater.

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Section 9

SECTION 9.0 REFERENCES

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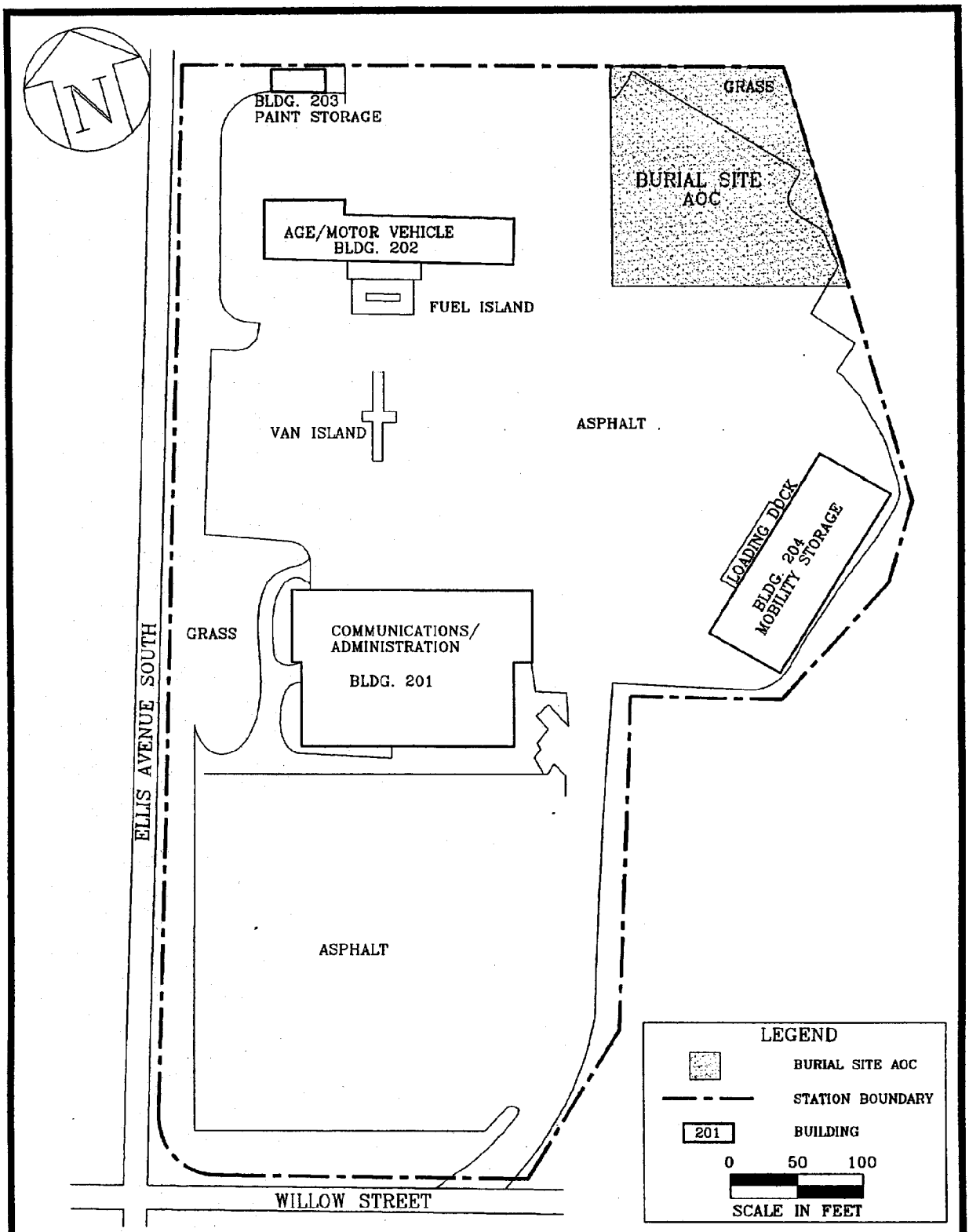

INSIDE BACK COVER

SEATTLE\SEA1-2SE

LOCATION OF AOC MAP

143rd CCSQ, Seattle ANGS

Seattle, Washington

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